SANTA CLARA VALLEY WATER DISTRICT

LLAGAS GROUNDWATER BASIN NITRATE STUDY

FINAL REPORT

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SANTA CLARA VALLEY WATER DISTRICT

PUBLIC DRAFT FINAL REPORT

LLAGAS GROUNDWATER BASIN NITRATE STUDY

CONTRACT NO. 1-053-250-0

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ABSTRACT

Over the years, the Santa Clara Valley Water District (District) observed that groundwater from municipal and private water supply wells installed in Llagas Groundwater Basin continued to contain concentrations of nitrate greater than those allowed by federal safe drinking water standards. As wholesale water supplier in Santa Clara County (County), and as manager of the County's groundwater basins, this trend concerned the District as the communities in the southern portion of the County rely solely on Llagas Groundwater Basin for their water supply.

To help ensure the utilization of Llagas Basin as the sole water supply for the Llagas Basin community, the District entered into a contract with the State Water Resources Control Board to further study the occurrence of nitrates and prepare management recommendations for the prevention and control of nitrate occurrence in Llagas Basin. Results of the study showed that nitrate concentrations were generally increasing over time, many different types of nitrate sources exist and contribute to the nitrate loading, and elevated concentrations of nitrates still exist throughout the basin today. Based on these results, the District developed management recommendations to reduce nitrate exposure, reduce nitrate loading, and monitor nitrate occurrence in Llagas Basin.

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I. INTRODUCTION

Communities in the southern portion of Santa Clara County (County) rely solely on groundwater from Llagas Basin for their water supply. Over the years, groundwater from municipal and private water supply wells has been found to contain concentrations of nitrate greater than those allowed by federal safe drinking water standards. The Santa Clara Valley Water District (District) is responsible for managing the groundwater basin to ensure its viability as a long term potable water supply. The District, as well as other local agencies, is concerned that the elevated nitrate concentrations in Llagas Basin may impact the utilization of the groundwater basin as the sole water supply. Therefore, in June of 1992, the District entered into an agreement with the State Water Resources Control Board (State Board) to review historical nitrate concentration data, identify potential nitrate sources, collect and analyze groundwater samples for nitrates, and develop a set of recommendations for the prevention and control of nitrates in Llagas Basin.

LAND USE

Figure 1 shows the location of the Llagas Basin study area. Current land use distribution in the Llagas Basin area is as follows: about 40 percent Agricultural, 25 percent Urban Service, 20 percent Rural Residential, and 5 percent Parks and Open Space. The remaining 10 percent of the land has various land use classifications such as Public Transportation, Educational/Institutional, and Public Facilities. These percentages are based on Santa Clara County's 1991 "Land Use Plan" and have been verified by Santa Clara County Department of Planning and Development staff (personal communication, 1993).

NITRATE HEALTH EFFECTS

The present Maximum Contaminant Level (MCL) for nitrate in drinking water is 45 milligrams per liter (mg/L), as promulgated by the United States Environmental Protection Agency (EPA). Drinking water supplies with concentrations exceeding this level are considered out of compliance, and require treatment and/or alternative supplies.

Elevated nitrate concentrations are a concern because of the susceptibility of infants to methemoglobinemia (blue baby syndrome) resulting from exposures to higher levels of nitrates in water. In addition, research is being done to determine whether excess nitrates in food and drinking water might also have long term carcinogenic (tendency to cause cancer) or teratogenic (tendency to cause fetal malformations) effects on exposed populations (personal communication with Santa Clara County, Department of Environmental Health staff, 1994).

FORMATION AND TRANSPORT OF NITRATES

Nitrate is produced when compounds which contain nitrogen (human and livestock waste, agricultural fertilizers, etc.) are introduced into the environment and transformed into nitrate in the soil via mineralization and nitrification. Mineralization is the process of organic nitrogen compounds being transformed into inorganic nitrogen compounds such as ammonium salts. Nitrification is the process of bacteria transforming those inorganic nitrogen compounds into nitrates. Except for certain chemical reactions that form minor amounts of nitrate from oxides of nitrogen in the atmosphere, this biological nitrification of nitrogenous compounds is the sole source of nitrate in the environment.

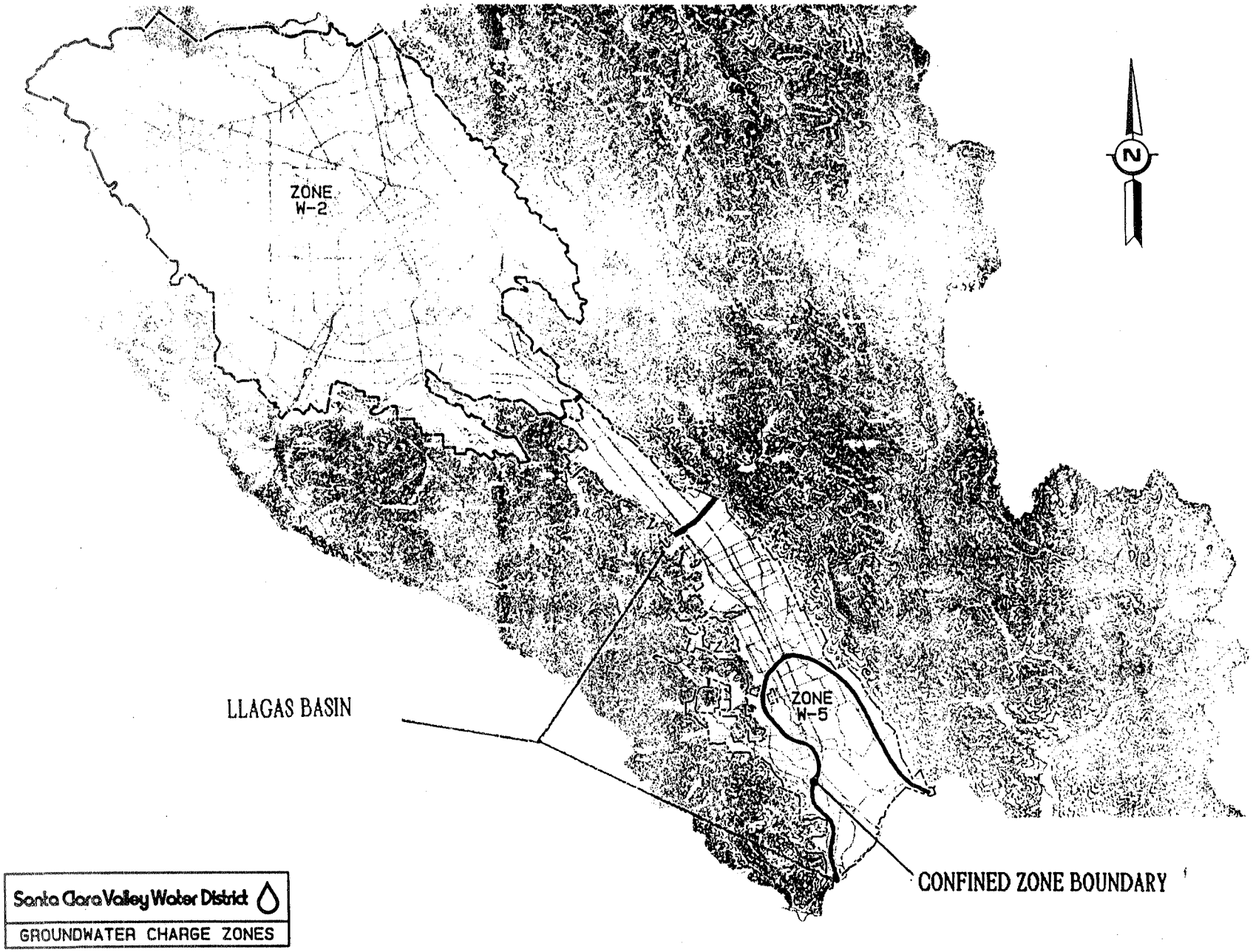


FIGURE 1: SANTA CLARA VALLEY AND LLAGAS BASIN

Once nitrogen containing compounds have been transformed into nitrate through mineralization and nitrification, the nitrate can dissolve in water percolating through the soil and be transported downward into groundwater aquifers. It can take a considerable amount of time for nitrate to reach groundwater because the vertical migration of nitrate is dependent on the amount of water infiltrating the soil, the soil type, and the depth to groundwater. After nitrates reach groundwater they typically move in the direction of groundwater flow.

Nitrates found in groundwater today may have originated from previous sources which are not reflected in current land uses because it may take a considerable amount of time for nitrate to be transported to groundwater. Though some practices which generate nitrate have been discontinued, groundwater quality may still be affected over time due to the transport of dissolved nitrates in water percolating through the soil. The time required for the movement of nitrate from the ground surface to groundwater depends on local conditions related to precipitation, transport in soil, plant nitrate uptake, and other processes. The nitrates which are found in groundwater today may have been released from the soil over several years or decades. Thus, soil containing high nitrate concentrations may still be considered a source of nitrate contamination to groundwater even though the practices that originally released the nitrogen to the soil have been discontinued.

OVERALL STUDY TASKS AND STATUS

The study began on October 1, 1991, and is scheduled to be completed on February 29, 1996. The agreement between the State Board and the District for the study consists of the following eleven tasks:

- Manage and Administer Project. Ongoing task.
- Conduct Public Participation Meetings. Completed.
- Develop Quality Assurance Project Plan. Completed.
- Review Historical Nitrate Data. Completed.
- Identify Nitrate Source Categories. Completed.
- Select Sample Collection Points. Completed.
- Collect and Analyze Samples and Data. Completed.
- Review Legislative Mechanisms and Prepare a Management Plan to Control the Nitrate Problem. Completed.
- Prepare Implementation, Institutional, and Financial Plans. Completed.
- Prepare Draft Final Report. Completed.
- Prepare Final Report[1]. Completed.

[1] Present status of the study.

All of the tasks have been completed. These tasks include developing a Quality Assurance Project Plan; completing the "Nitrate Data Review" report dated August 1993, which summarized and evaluated nitrate data from previous studies; completing the "Nitrate Source Area Identification" report dated December 1994, which identified and attempted to quantify the sources of nitrate present in Llagas Basin; completing the "Sample Point Selection" report dated December 1994, which summarized the methodology for selecting nitrate sample collection points and presented the selected wells; completing the "Sample Analysis" report dated May 1995, which discussed the results of our groundwater sampling; and completing the "Draft Final Report" dated August 1995, which reviews institutional mechanisms, and presents nitrate management, implementation, institutional, and financial recommendations. Based on the results of the previous phases of this study and comments from our Technical Advisory Committee (TAC), the District's Agricultural Water Advisory Committee, and the Retail Water Agencies Groundwater Subcommittee, the District has prepared this Final Report for review and comment.

II. PUBLIC PARTICIPATION

Public participation and outreach was a primary goal of the District during this study, especially during the development of nitrate management recommendations. The public and all potentially affected governmental agencies were made aware of our study and were provided information on an ongoing basis during various committee and special interest group meetings.

TECHNICAL ADVISORY COMMITTEE

A TAC was formed as one of the first steps of the study so that representatives with various interests could be an integral part of the study, especially during development of our nitrate management recommendations. The TAC included representatives from the agricultural community, local city and county governments, planning committees, private industry, and the water quality profession. A private citizen was also invited to participate on the TAC. A complete list of TAC members is included in Appendix B.

The TAC provided comments during development of the key documents of the study. Outlines and drafts of key documents, such as the table of nitrate management alternatives, were mailed to TAC members for comment, and were discussed during TAC meetings and telephone conversations.

PUBLIC WORKSHOPS

During the course of this study, we conducted two public workshops to inform the public of our progress and to hear their concerns. The first public workshop was held during December of 1992, in Gilroy. At that workshop, District staff and management presented the purposes and stages of the study to the public. An overview of the District's historical nitrate data review was also presented.

The public raised many concerns at this workshop. One concern was that we may not be performing the nitrate data review and source identification portions of the study comprehensively enough. Also, members of the public expressed various opinions regarding the severity of nitrate contamination and relative contributions of several suspected nitrogen sources. Concerns from this workshop were either incorporated into our study or responded to in our Responsiveness Summary dated August 22, 1994.

The second public workshop was held in December of 1995. The purpose of this workshop was to receive comments from the public on our "Public Draft Final Report." Although the public was represented by the TAC during the study, we held a second public workshop in order to obtain direct feedback from the public.

During this meeting, we received approximately 50 comments on the Draft Final Report. These comments were responded to in a Responsiveness Summary that was distributed to all interested parties. All comments were evaluated for incorporation into this report.

FOCUS MEETING

After sending our Draft Final Report to the State Board and our TAC in September 1995, we held a focus meeting to hear their comments on the Draft Final Report. The District's Agricultural Water Advisory

Committee and the Retail Water Agencies Groundwater Subcommittee, who have expressed an interest in this study, were also invited to the focus meeting. All comments were evaluated for incorporation into the Public Draft of the Final Report. In general, the comments were favorable.

OTHER COMMITTEES

During the study, progress reports were presented regularly to several committees having a special interest in our study. These committees included the District's Agricultural Water Advisory Committee, the Retail Water Agencies Groundwater Subcommittee, and the District's Board of Directors. We also gave presentations to other interest groups, such as the San Martin Planning Advisory Committee, the San Jose Chamber of Commerce, the South County Joint Planning Advisory Committee, and a groundwater professionals' association.

III. GEOLOGY AND HYDROGEOLOGY OF LLAGAS BASIN

The geologic history of Llagas Basin has resulted in a complex hydrogeologic system consisting of confined and unconfined aquifers. As shown in Figure 1, Llagas Basin extends southeasterly from the southern end of Coyote Valley at the interconnecting topographic divide to the southern boundary of the County at the Pajaro River. In general, the basin is divided into three hydrographic units. The northern portion of the basin and the elevated lateral edges of the basin constitute the forebay and the southern flat interior portion is divided into upper and lower aquifer zones (similar to Santa Clara Valley Basin).

The forebay is comprised predominantly of aquifer materials with discontinuous aquitards, is unconfined, and is the principle basin recharge zone. Recharge is from subsurface inflow from Coyote Valley where a groundwater mound occurs beneath the topographic divide, from deep percolation of streams, principally along Llagas Creek north of Rucker Avenue, and from Uvas Creek west of U.S. Highway 101. Minor amounts of recharge can also be attributed to rainfall, irrigation returns, and from the subsurface flow from nonwater-bearing formations that laterally bind the basin. Within the forebay, groundwater generally flows from the topographic divide southeasterly down the basin toward the flat south central part of the basin.

Confining conditions which create both upper and lower aquifer zones occur in the flat southern interior portion of the basin and continue southerly past the County line into the Hollister Basin. The separation between the upper and lower aquifers is formed by a continuous regional aquitard that occurs at varying depths from about 20 to 100 feet, and extends from approximately Rucker Avenue to the south basin boundary. The thickness of this major aquitard varies from about 40 to 100 feet. Both upper and lower zones are stratified with aquifers and aquitards.

Groundwater in the upper aquifer zone is unconfined in the uppermost aquifer and confined or partially confined in deeper aquifers. The depth to groundwater in this zone is usually shallow and generally flows southeasterly, to the Pajaro River. Recharge to the upper aquifer zone is from surface sources and from subsurface flows from the forebay.

Numerous individual aquifers occur in the lower aquifer zone. Groundwater in these aquifers is confined and generally flows to the southeast except where the regional gradient is interrupted by pumping troughs. Subsurface flow from the forebay recharges these aquifers. From the mid-1800s, wells tapping the southern portion of this zone, south of Old Gilroy, were flowing artesian wells (Clark, 1924). With a greater amount of pumping in more recent times in proportion to growing water demands, the artesian pressures have declined and now only a few of the wells in the southernmost portion of the basin flow under pressure and are only on a seasonal basis. In Llagas Basin most of the waters are pumped from the forebay and lower aquifer zones, though many of the wells in the flat southern interior portion of the basin pump from both upper and lower aquifer zones.[2]

IV. NITRATE DATA REVIEW

During this phase of the study, we evaluated nitrate-laden groundwater quality data from previous studies conducted in the Llagas Basin area over the last 35 years. Data was collected from approximately 837 wells and used to divide the wells into categories of nitrate concentration ranges: <25 mg/L; 25-45 mg/L; 45-70 mg/L; 70-100 mg/L; and >100 mg/L. Placement of a well into a particular range was based on the highest concentration of nitrate historically observed in each well. Wells were also identified as either shallow or deep based on whether they primarily represented zones less than or greater than 150 feet

Table 1 summarizes the distribution, status, and depth of wells in each category. Wells below 25 mg/L were not included to simplify presentation. This explanation as well as other aspects of this phase of the study are discussed in more detail in our "Nitrate Data Review" report dated August, 1993. A synopsis of our findings and limitations associated with those findings is presented below.

TABLE 1
Summary of Wells in Each Nitrate Concentration Category

Nitrate Concentration Category[1]	No. of Wells	% of Total	Well Status			Well Depth[4]		
			Active[2]	Destroyed or Inactive	Unknown or Unrecorded[3]	Known		Unknown or Unrecorded
						<150'	>150'	
25-45 mg\L	214	43	153	6	55	13	56	145
45-70 mg\L	178	36	122	5	51	14	50	114
70-100 mg\L	77	16	62	2	13	5	18	54
>100 mg\L	23	5	16	0	7	3	3	17
TOTAL	492	100	353	13	126	35	127	330

Notes:
1 Based on highest historical concentration recorded.
2 An active well is one which has produced water over the past year.
3 Based on information available to the District, it is uncertain whether this category of wells is currently in use.
4 Perforated intervals and lithologic information unavailable for most wells.

FINDINGS

Based on an analysis of the historical data we collected, we were able to draw the following conclusions:

Spatial Distribution

The location of wells containing nitrate concentrations <70 mg/L appears random and scattered throughout Llagas Basin, as seen in Figures 2 and 3. However, wells containing nitrate concentrations >70 mg/L appear to be located in the confining layer in the southern portion of the basin, as seen in Figures 4 and 5.

Trend Analysis

A total of six wells were used to study nitrate concentration trends in Llagas Basin. Using least square linear regression as shown in Figures 6 through 11, the data indicated a gradual increase of nitrate concentration over time.

Nitrate Concentration Versus. Groundwater Elevation

Fluctuations in the groundwater table may affect nitrate concentrations. However, analysis of the data did not indicate a strong correlation.

LIMITATIONS

We encountered several limitations during this phase of the study. First, specific well construction data was unavailable for many of the wells which were sampled because many of the existing wells were drilled before drilling logs were required. Lacking this important information has limited the District in drawing conclusions regarding the vertical extent of nitrate distribution in groundwater. References to nitrate concentrations in this survey are not necessarily indicative of the nitrate concentration in a specific aquifer, but rather, represent all of the aquifers at which the well is perforated. This "averaging" effect of the well tends to underestimate actual concentrations that may be present in any single aquifer.

Second, due to the laminar nature of groundwater flow, turbulent mixing and vertical mixing between aquifers is limited. A third limitation is the possibility that sampling techniques varied between studies. Items such as well purging, sample collection method, sample holding time, and laboratory Quality Assurance/Quality Control procedures may affect the comparison of results. Sample holding time is more significant for wastewater, where abundant organic matter reduces the nitrate concentrations. In groundwater, the holding time is not as significant, however, high holding times may still result in slightly under-reported nitrate concentrations.

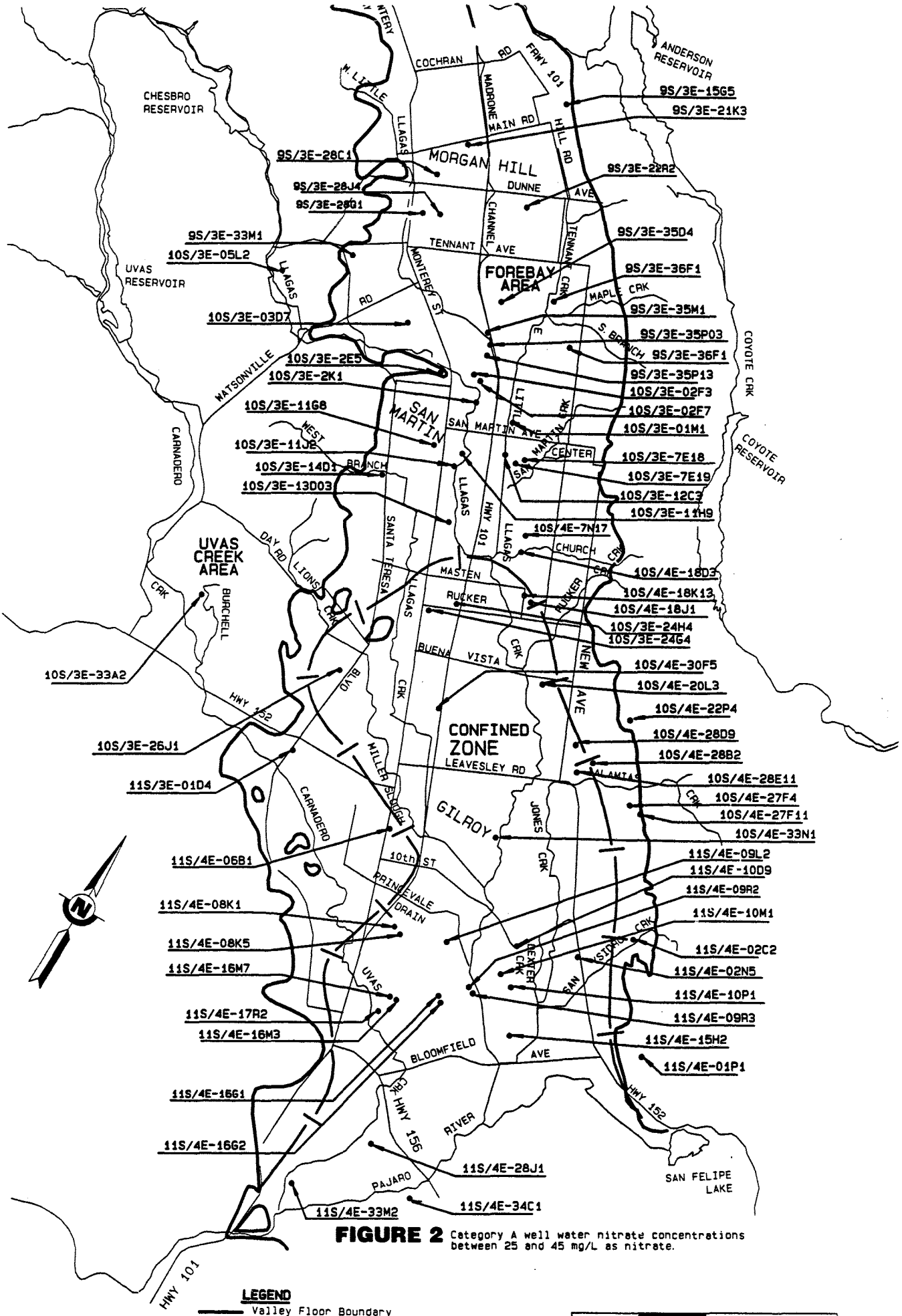


FIGURE 2 Category A well water nitrate concentrations between 25 and 45 mg/L as nitrate.

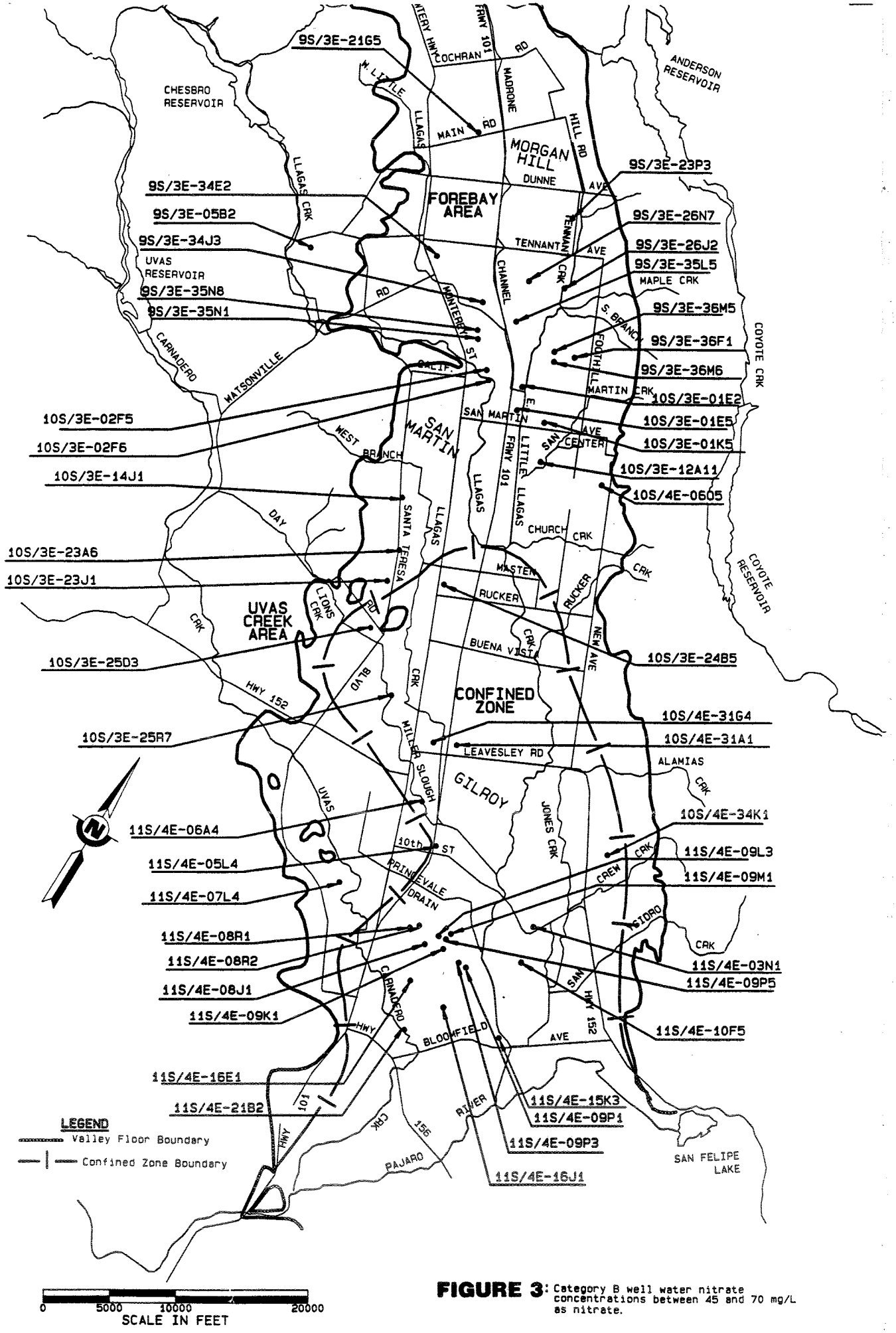


FIGURE 3: Category B well water nitrate concentrations between 45 and 70 mg/L as nitrate.

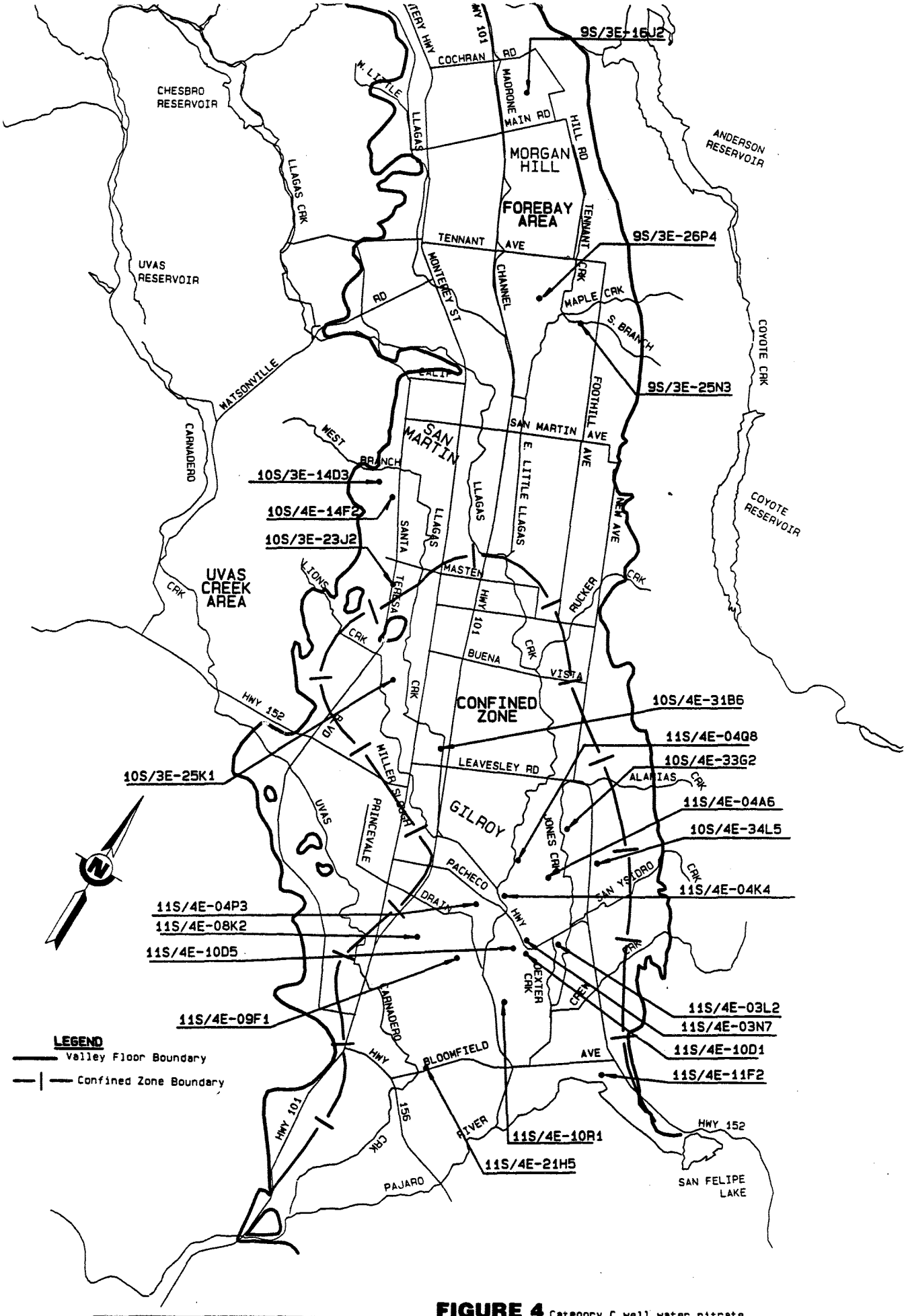


FIGURE 4 Category C well water nitrate concentrations between 70 and 100 mg/L as nitrate.

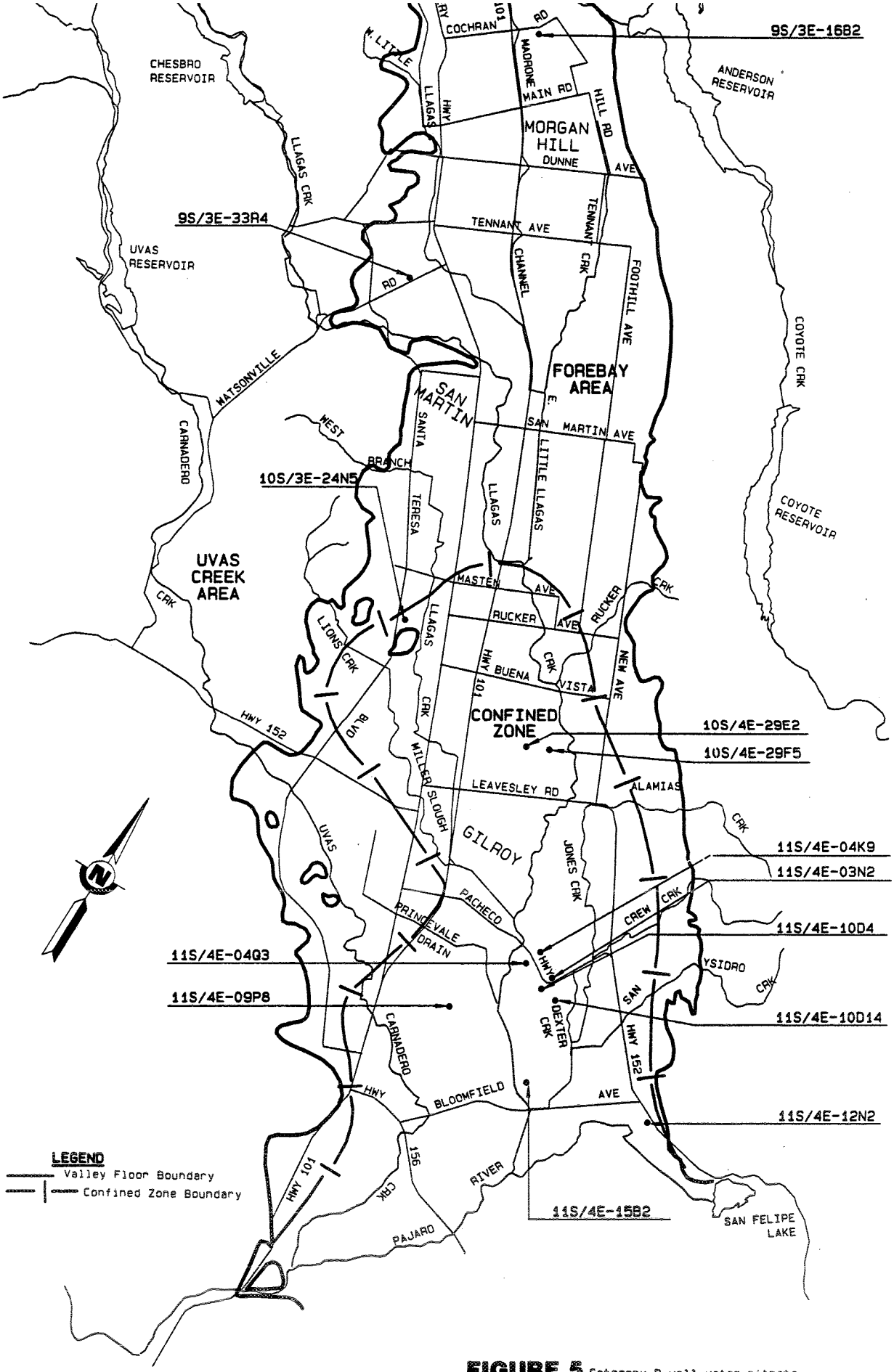


FIGURE 5 Category D well water nitrate concentrations exceeding 100 mg/L as nitrate.

Nitrate Trends in Well #10S3E26J1

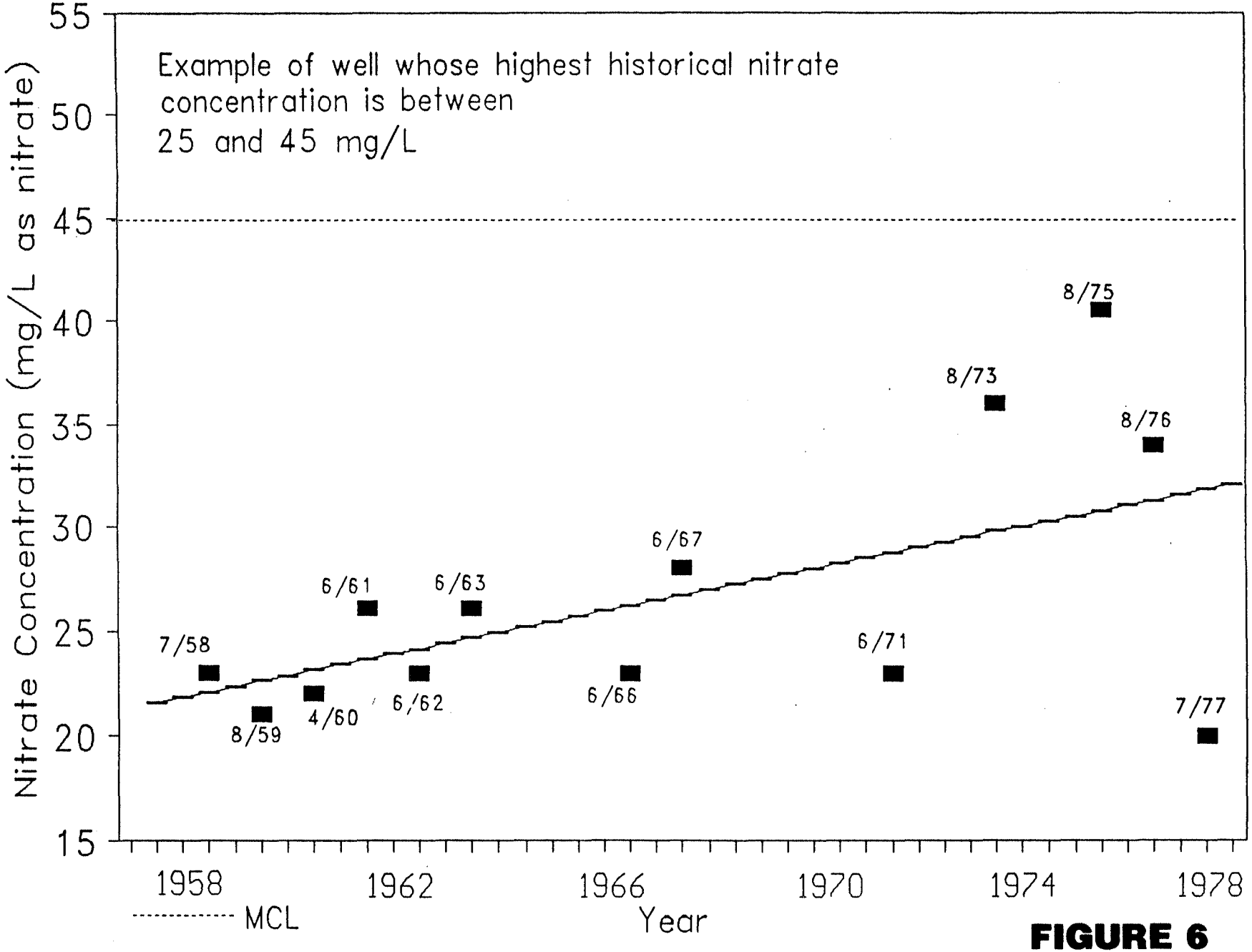


FIGURE 6

Nitrate Trends in Well #10S4E18J1

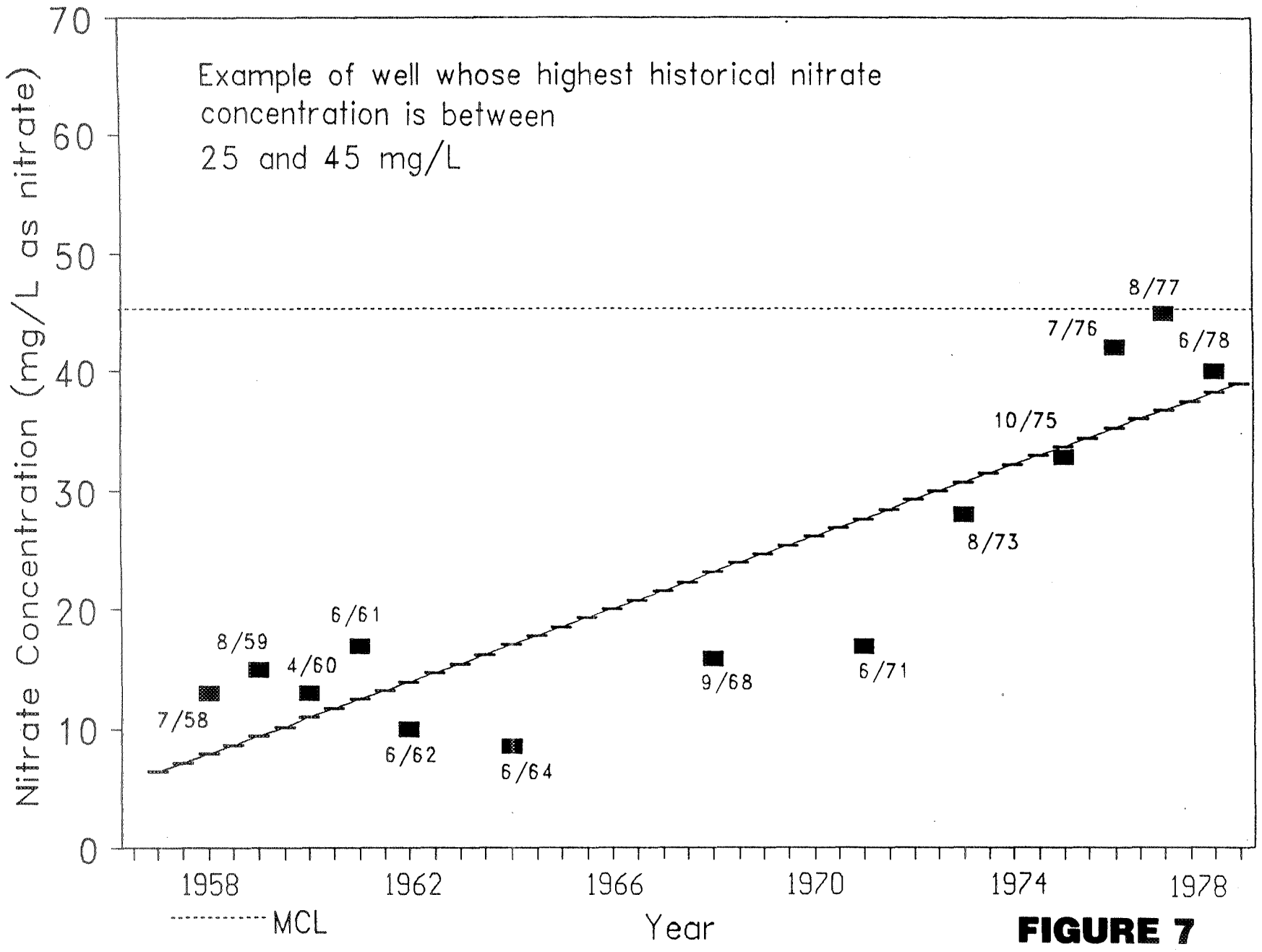


FIGURE 7

Nitrate Trends in Well #10S3E01E2

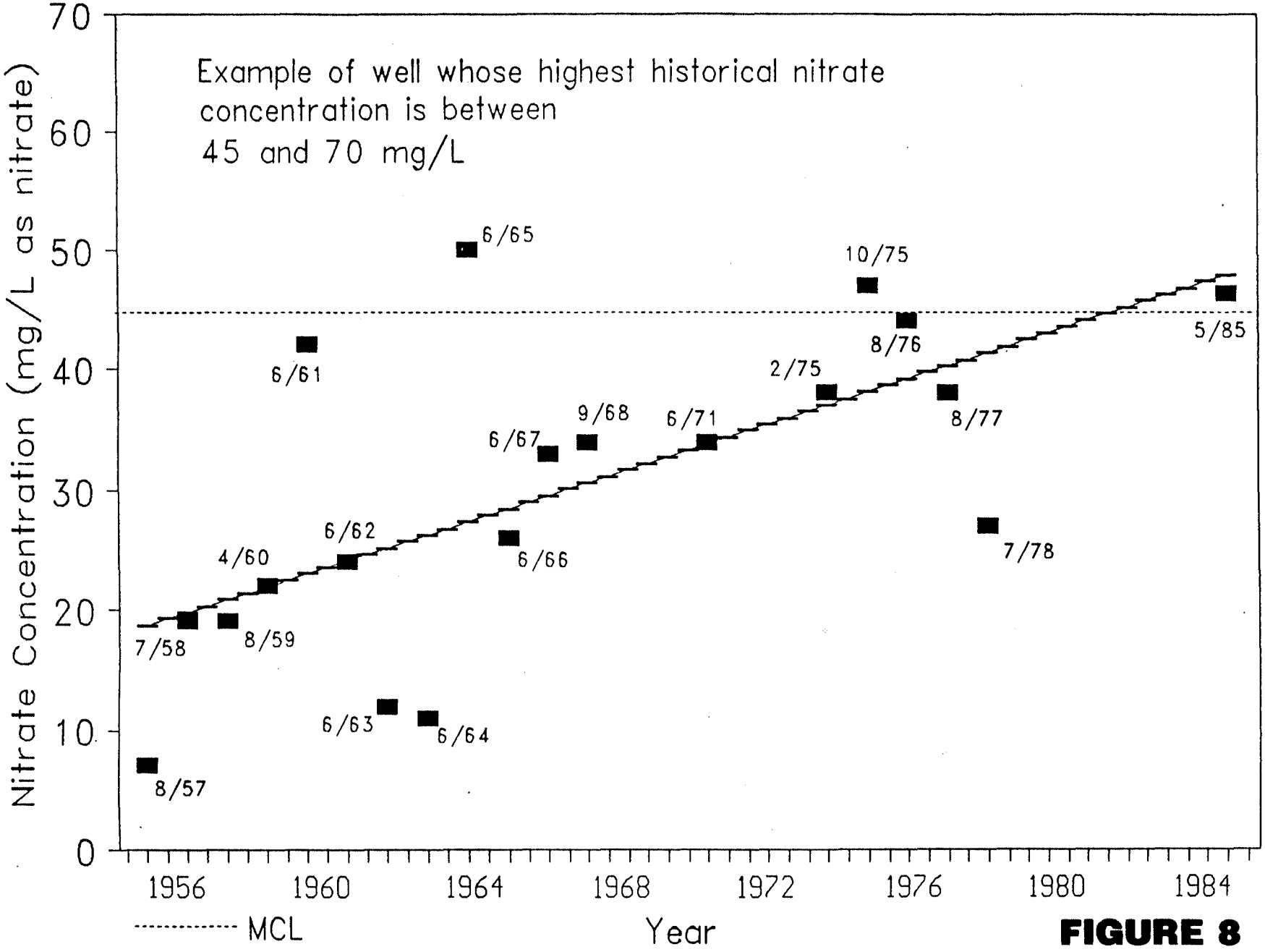


FIGURE 8

Nitrate Trends in Well #11S4E21B2

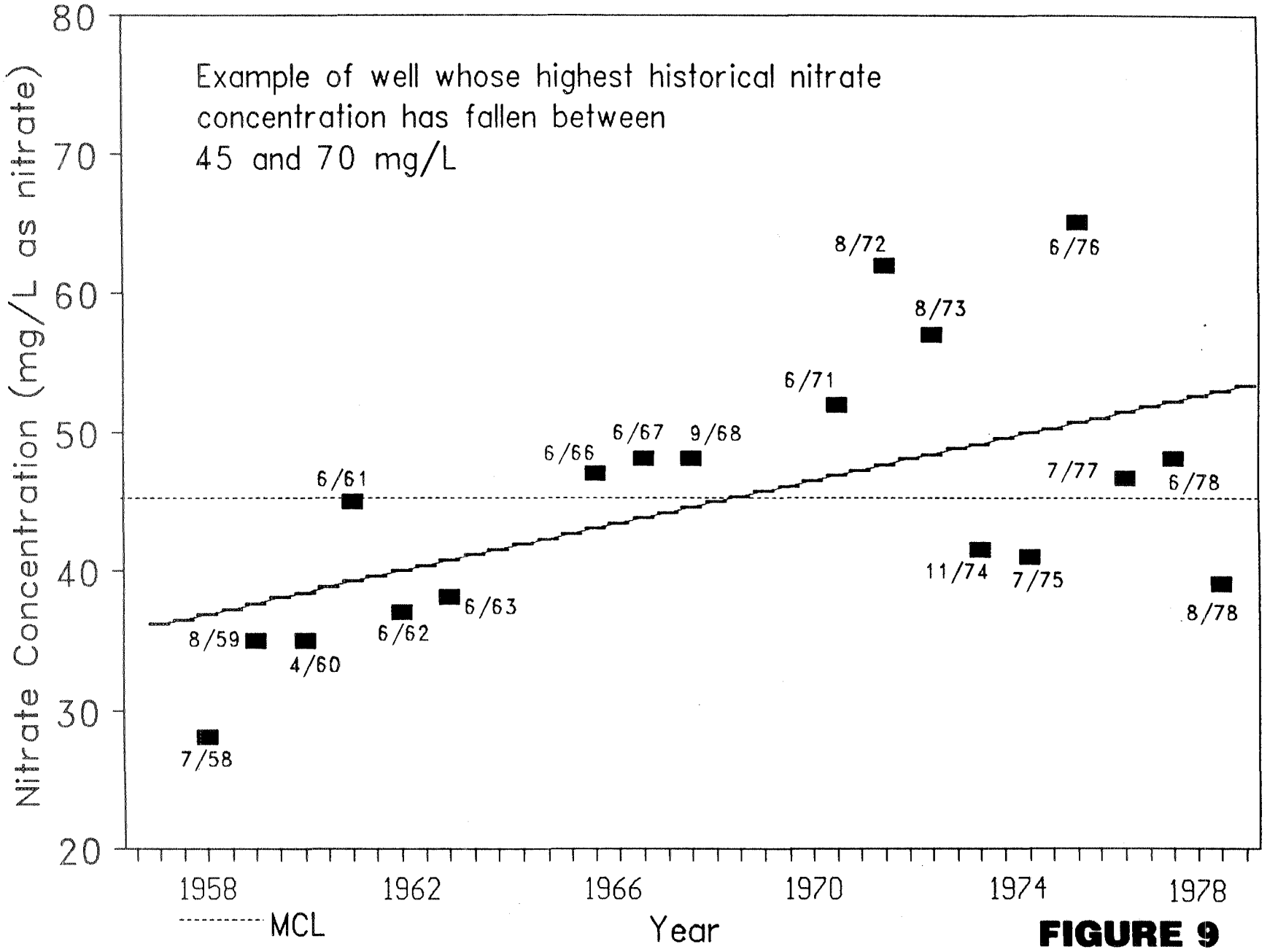


FIGURE 9

Nitrate Trends in Well #10S4E34L5

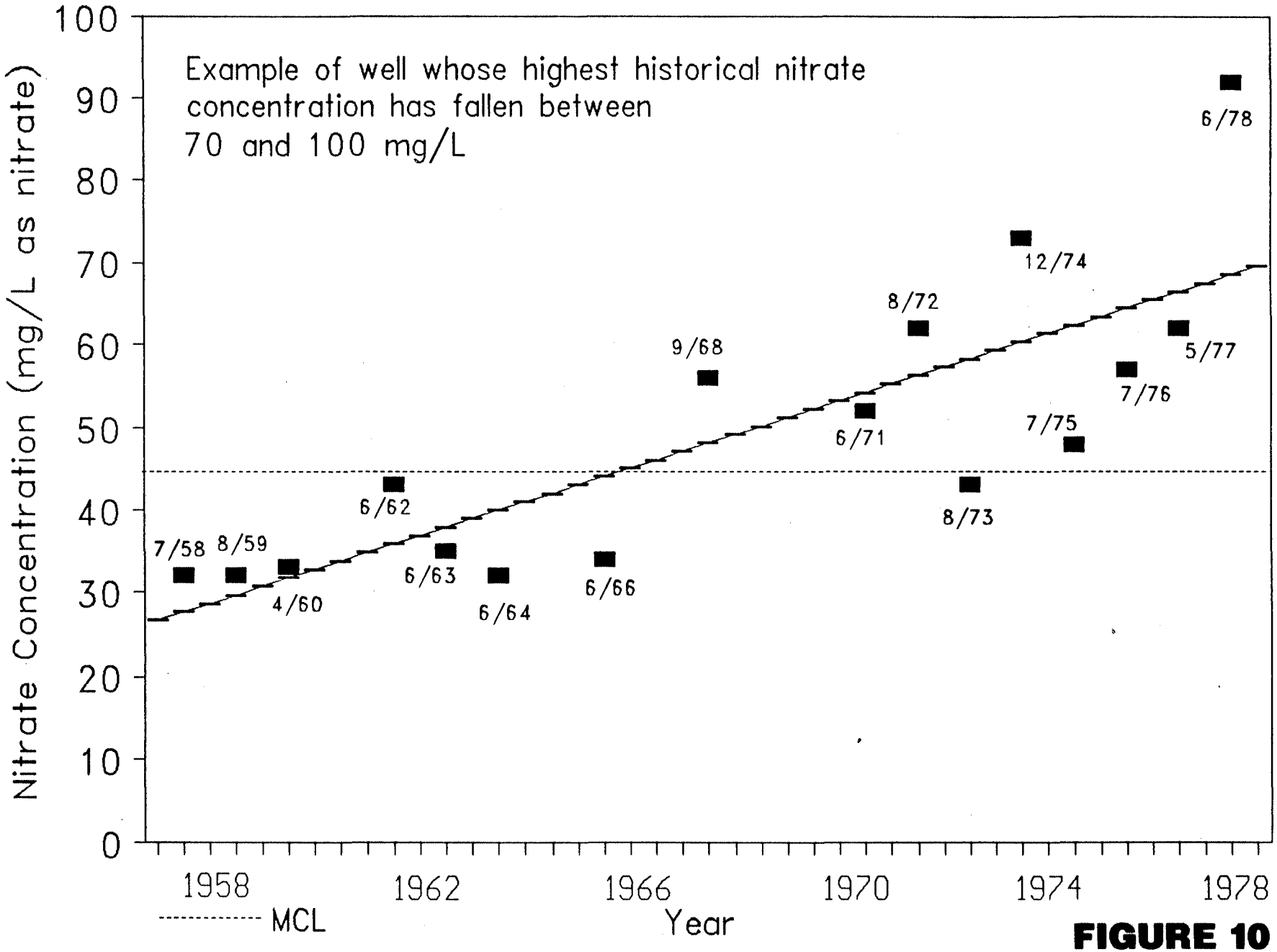


FIGURE 10

Nitrate Trends in Well #11S4E04Q3

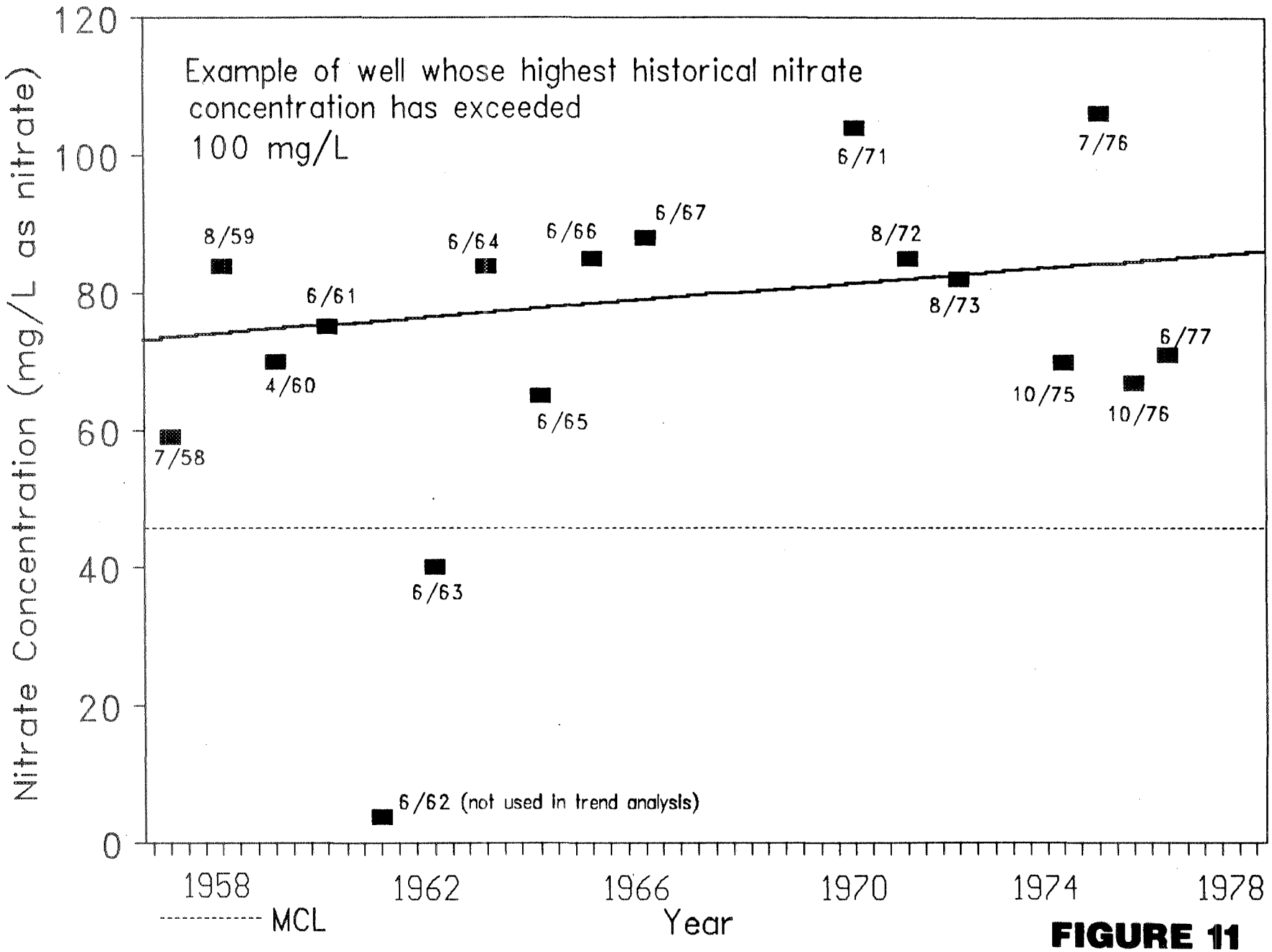


FIGURE 11

V. NITRATE SOURCE AREA IDENTIFICATION

After reviewing and evaluating historical nitrate concentration data, we began to evaluate potential point and nonpoint sources of nitrate contamination in the Llagas Basin area. The goal of this phase of the study was not to identify specific facilities that contribute to our nitrate problem, but rather, to get a sense of the relative contributions of each type of source.

Due to the nature, extent, and number of potential nitrate sources in Llagas Basin, it is difficult to determine the exact amount of nitrogen loading contributed by each particular source. Detectable concentrations of nitrate discovered in a well today may be from a single source, or from a combination of sources. Past nitrate management practices, or lack of them, may still be affecting groundwater quality in the basin, because transport and transformation of nitrogenous compounds from the ground surface to groundwater may take months or years depending on local subsurface conditions.

During this phase of the study, we studied aerial photographs and maps, reviewed groundwater quality reports and technical literature, and conducted oral interviews. Several types of nitrate contamination sources were identified in this portion of the study. Details concerning the identification of nitrate sources are documented in our "Nitrate Source Area Identification" report dated December 1994. A summary of our findings and the limitations associated with those findings are presented below.

FINDINGS

The nonpoint sources that we identified and that are discussed in our "Nitrate Source Area Identification" report are commercial and manure fertilized agricultural areas, other fertilized areas such as large lawns and golf courses, septic tank areas, rainwater, other natural nonpoint sources, such as organic soil matter of crop lands and natural areas of grass and forests, domestic livestock, and illegal disposal of wastes. The following point sources are discussed in that report as well: dairies, cattle feed lots, egg farms, food packing operations, wineries, cogeneration facilities, sewage treatment facilities, sewage disposal pits, mushroom farms and composting operations, and greenhouse operations.

In order to assess and compare the relative contribution of each particular source, calculations were made to estimate potential nitrogen loadings from those quantifable sources. Unquantifable sources were evaluated qualitatively. Our quantitative and qualitative information was based on published literature and personal communications.

Table 2 shows the summary of estimated nitrogen loadings to groundwater from each quantifiable source. The results indicate that fertilized agricultural lands and septic tank areas have been the two major sources of nitrate contamination; feed lots and egg farms can be significant point sources if proper waste management is not carried out; and greenhouse operations appear to be a potentially significant source. Based on a qualitative evaluation, we concluded that the unquantifable sources do not contribute significantly to the nitrate loading of Llagas Basin,.

Future land use in the area has the potential to affect nitrate loading to the Llagas Basin. Depending on the type of agricultural activities and the density of residential development in the future, the loading may increase or decrease. According to the Santa Clara County Office of Planning and Development, land use changes will most likely be insignificant, at least for the next decade (personal communication, 1994) leaving loading rates to the basin relatively constant. Current zoning policy regarding parcel size, as well as Santa Clara County, Department of Environmental Health's active encouragement of both enhanced

sewage treatment technologies and connections to existing municipal sanitary sewers, for existing or new higher density developments, will most likely have a positive effect on nitrate loading to the basin. However, if additional nitrate management practices are not implemented reduce the total nitrogen loading in the basin, nitrate concentrations in the groundwater in the basin can be expected to remain high. This would continue to adversely affect the utilization of groundwater as a source of drinking water.

LIMITATIONS

This phase of the study focused on identifying representative point and nonpoint source areas in Llagas Basin. Identification of all the nitrate sources in the past, present, and projected for the future was limited by the availability of data from land use maps, aerial photographs and reports which did not provide a full picture of the basin. When a source type was identified as potentially existing in the basin, efforts were made to use other information sources to confirm whether the source type actually exists or existed. While some minor potential sources of nitrate may not have been identified, the District is confident that all significant sources of nitrate have been identified.

TABLE 2
Summary of Estimated Potential Nitrogen Loadings to Groundwater

		Total Potential Nitrogen Loadings[1,2] Thousands Pounds				
		Year				
		1967	1970	1978	1980	1990
Nonpoint Source	Agricultural Lands Fertilized by Commercial N-Fertilizer	276		250		227
	Agricultural Lands Fertilized by Beef Cattle Manure					8.1-26.9
	Septic Tank Areas		44-123		49-140	53-151
	Rainwater					14
Point Source	Dairies					4.6-6.9
	Cattle Feed Lots[3]					162-538[3]
	Egg Farm[4]					90-151[4]
	Food Packaging Operations					3.5-5.2
	Cogeneration Facility					2.2-3.3
	Sewage Treatment Facilities					2.1-3.1[5]
	Sewage Disposal Pits					0.47-0.70
	Mushroom Farms/ Composting Operation					0.16-0.23
	Greenhouse Operations					11-54

[1] Amounts of nitrogen available for potential leaching to groundwater after nitrogen losses due to volatilization, denitrification, and/or plant uptake.
[2] For the study area.
[3] Assumed no proper waste management.
[4] Assumed all the manure is stored in an open lot with no proper waste management.
[5] The Gilroy/Morgan Hill wastewater treatment facility now treats nitrate so that discharges are not above 5 mg/L nitrate nitrogen, an improvement from the 1990 discharge rate.

VI. SAMPLE POINT SELECTION

While identifying potential point and nonpoint sources, we began our sample point selection process. Wells were selected to provide us with various types of data relevant to the study. Some of the wells were selected for the specific purpose of monitoring groundwater quality up and downgradient of different suspected nitrate source areas in the study area. Several of the wells selected for sampling were intended to provide recent data to add to historical data already compiled for those wells, thus improving the quality of our nitrate trend analysis. Other wells were picked to produce samples representative of shallow and background groundwater quality in Llagas Basin. We also planned to collect a rainwater sample during the sample collection phase of the study.

The process used to select wells for sampling is described in our "Sample Point Selection" report dated December 1994. A brief discussion is presented below, along with limitations of this phase of the study.

FINDINGS

In general, we looked at the following seven factors to help us create criteria for the well selection process: (1) nitrate sources, (2) hydrogeologic parameters, (3) historical nitrate data, (4) well construction information, (5) well status, (6) historical groundwater elevation data, and (7) well logs. As seen in Table 3, our process resulted in a total of 28 wells being selected for groundwater sampling.

LIMITATIONS

We discovered during our selection process that despite the large number of water supply wells in Llagas Basin, complete well construction information was available for only a few wells. Although construction information was available for over a third of the wells in the study area, we selected some wells without construction information due to the wells' appropriate locations in the basin or locations relative to nitrate sources. Very few of the wells which had a significant number of previous nitrate results also had available construction information. This fact limited the conclusions which could be drawn from previous sampling rounds, by preventing us from collecting samples for our study which could confirm which aquifer contains high nitrate concentrations in the water. Continuation of nitrate trend analysis in specific aquifers was also precluded. Two wells which are completed only in first encountered shallow groundwater were selected to specifically monitor that zone. Collecting samples from above the confining layer may also help our evaluation of the sources of nitrate in well water in the southern area of Llagas Basin.

TABLE 3
Selected Wells for Sampling

State Well Number	Well Type[1]	Construction Details[1] (Depths and Screens[2] in Feet Below Ground Surface)	Identified Nitrate Sources in Vicinity of Well and/or Well Ranking as Applicable (If well is example or trend[3]; range[4] in mg/l[5] of NO_3^- as NO_3^-)
10S3E01E2	Domestic	Depth = 250	Example well: 45-70
10S4E18J1	Domestic	Depth = 180	Example well: 25-45
10S4E34L5	Agricultural and Domestic	--[6]	Example well: 70-100
9S3E35D4	Domestic		Trend well: 25-45
10S4E17F1	Domestic	Depth = 360 Screened interval = 240-360	Trend well: <25
10S4E18G2	Agricultural	Depth = 130	Trend well: 25-45
10S3E02C5	Domestic	Depth = 200 Screened Interval = 140-200	Upgradient from food processing facility
10S3E02L1	Domestic	Depth = 187	Downgradient from food processing facility
9S3E36B7	Domestic	Depth = 225 Screened Interval = 165-225	Downgradient of sewage disposal pits
9S3E36C3	Domestic	Depth = 220 Screened Intervals = 100-120; 140-160; 80-220	Upgradient of sewage disposal pits
11S4E09E1	Domestic	Depth = 400 Screened Intervals = 130-210, 250-310; 350-390	Upgradient of wastewater treatment plant

State Well Number	Well Type[1]	Construction Details[1] (Depths and Screens[2] in Feet Below Ground Surface)	Identified Nitrate Sources in Vicinity of Well and/or Well Ranking as Applicable (If well is example or trend[3]; range[4] in mg/l[5] of NO_3^- as NO_3^-)
11S4E16R2	Agricultural	Depth = 480 Screened Intervals = 270-320; 340-360; 450-470	Downgradient of wastewater treatment plant
10S3E11D10	Agricultural and Domestic	Depth = 181 Screened Intervals = 80-100, 121-141; 161-181	Upgradient of winery
10S3E12N13	Municipal and Industrial	Depth = 126 Screened Interval = 116-126	Downgradient of winery
10S3E12M10	Municipal and Industrial	Depth = 200 Screened Interval = 120-200	Downgradient of winery
10S4E17M10	Domestic	Depth = 210 Screened Interval = 80-120	Upgradient from dairy
10S4E20B4	Domestic	Depth = 220 Screened Interval = 55-220	Downgradient from dairy
9S3E34H3	Agricultural and Domestic	Depth = 200 Screened Intervals = 112-135; 178-184	Upgradient of San Martin Special Use Area
9S3E26J8	Domestic	Depth = 175 Screened Intervals = 135-175	Upgradient of San Martin Special Use Area
10S3E24H4	Domestic	Depth = 200 Screened Interval = 85-180	Downgradient of San Martin Special Use Area
10S4E17E3	Domestic	Depth = 200 Screened Interval = 180-200	Downgradient of San Martin Special Use Area
9S3E36B6	Domestic	Screened Interval = 185-225	Upgradient of San Martin Special Use Area

TABLE 3
Selected Wells for Sampling
(continued)

State Well Number	Well Type[1]	Construction Details[1] (Depths and Screens[2] in Feet Below Ground Surface)	Identified Nitrate Sources in Vicinity of Well and/or Well Ranking as Applicable (If well is example or trend[3]; range[4] in mg/l[5] of NO_3^- as NO_3^-)
10S3E01N1	Monitoring	Depth = 30 Screened Interval = 10-30	Shallow well
11S4E05K10	Monitoring	Depth = 35.5 Screened Interval = 10-35	Shallow well
10S4E07K6	Monitoring	Depth = 237 Screened Interval = 187-237	Downgradient of agricultural field
10S4E07E33	Domestic	Depth = 228 Screened Interval = 180-228	Upgradient of agricultural field
10S3E18J1	Domestic		Background well—Uvas Creek area
9S3E31G5	Domestic	Depth = 55 Screened Intervals = 20-30; 45-55	Background well—Llagas Creek area

[1] Well type and construction information was obtained from the District's Water Revenue Department.
[2] Most of above wells with screening intervals reported have sanitary seals of approximately 50 feet. Some wells with reported screening intervals and all wells without reported screening intervals do not have a reported sanitary seal length.
[3] Previous sampling results were obtained from sources listed in "Review of Nitrate Data" report for this study.
[4] Concentration ranges are reported based on the highest nitrate concentration historically observed in that well, as in ``Review of Nitrate Data'' report.
[5] mg/l = milligrams per liter
[6] Items left blank = not available or not applicable.

VII. SAMPLE ANALYSIS

During December of 1993 and February/March of 1994, groundwater samples were collected from the 28 wells we selected, and analyzed for a suite of parameters. These parameters included the following: nitrate, nitrite, dissolved oxygen, stable nitrogen isotope ($\delta^{15}N$) analysis, stable oxygen isotope analysis ($\delta^{18}O$), Total Kjeldahl Nitrogen (TKN), ammonia, chloride, and coliform bacteria.

Methods of sample collection and analysis are described in the "Quality Assurance Project Plan'"dated August 1992 (revised November 1993). A detailed discussion of the sample analysis results is found in the "Sample Analysis" report dated May 1995. A summary of our conclusions and the limitations associated with those conclusions are presented below.

FINDINGS

Tables 4 and 5 present the analytical results of our sample collection. The data we collected was reviewed in conjunction with historical nitrate results and nitrate source information from the study area. It is important to note that significant limitations were encountered during our study which preclude us from making certain conclusions. Our results and the limitations associated with this phase of the study are discussed below.

Nitrates

An evaluation of the nitrate data resulted in the following conclusions:

Spatial distribution

Consistent with conclusions drawn in our "Nitrate Data Review" report dated August 1993, our sampling program confirmed the presence of localized areas of nitrate contamination located throughout Llagas Basin. This does not imply that the entire groundwater basin is contaminated with nitrates, but does indicate that nitrate occurrence is not restricted to any particular location in the study area. Also, the sampling results for this study were consistent with historical data. This consistency shows that the southern portion of the study area appears to contain a higher percentage of water-producing wells with nitrate concentrations significantly exceeding MCLs than the northern portion. See Figure 12.

Vertical Distribution

Nitrate appears to be present at various depths. Water collected from the two wells screened in the shallow zone contained high concentrations of nitrates, up to 3 times higher than the MCLs. Nitrate above MCLs was also discovered in wells reportedly screened in only a deep water-bearing zone. Depth-specific nitrate profiles were not developed, due to the limited number of aquifer-specific monitoring wells. However, we did plot nitrate concentrations versus top and midpoint of the reported screen interval, as well as nitrate concentrations versus total well depth. A loose correlation indicating that nitrate concentrations decrease with deeper perforated intervals was evident.

TABLE 4

: Sample Results - Sampling Round 1 (December 1993)

Well I.D.	Well Purpose	Well Type	Reported Depth (feet)	Reported Screen(s) (feet bgs)	Nitrate # (Illinois)	Nitrate (Sequoia)	Nitrate + Nitrite # (C & T)	Nitrite	Dissolved Ox.	Delta 15-N	Delta 18-O	TKN	Ammonia	Chloride	Total Coliform (colonies / 100 mL)
10S3E01E2	E	domestic	250		68		81		7.17	3.53	-5.80			42	
10S4E18J1	E	domestic	180		33		36		11.73	3.41	-6.00			45	
10S4E34L5	E	ag. and domestic	163		65	75		nd	8.01	2.51	-6.05			70	
9S3E35D4	T	domestic			30		33		8.81	0.10	-6.04			32	
10S4E17F1	T	domestic	360	240-360	2.0		3.0		0.24	7.36	-6.31			36	
10S4E18G2	T	agricultural	130		32		37			2.02	-6.22			32	
10S3E02C5	F	domestic	200	140-200	17		21			-1.09	-7.45			80	
10S3E02L1	F	domestic	187		25		31		5.82	4.73	-5.31			28	
9S3E36B7	SDP	domestic	225	165-225	26	33		nd	7.80	1.27	-5.97			90	
9S3E36C3	SDP	domestic	220	100-120; 140-160; 180-220	45		81		10.08	-1.14	-5.90			130	
11S4E09E1	STP	domestic	400	130-210; 250-310; 350-390	56	68		nd	10.15	2.10	-5.79	nd	nd	30	
11S4E16R2	STP	agricultural	480	270-320; 340-360; 450-470	17		34		16.66	8.40	-5.78	nd	nd	70	
10S3E11D10	W	ag. and domestic	181	80-100; 121-141; 161-181	33		41		6.98	0.39	-5.60			28	
10S3E12N13	W	muni. and indust.	126	116-126	4.3	6.8		nd	4.22	4.23	-5.06			33	
10S3E12M10	W	muni. and indust.	200	120-200	20		23		9.00	3.98	-5.37			15	
10S4E17M10	D	domestic	210	80-210	29		31		11.18	3.04	-6.25			46	
10S4E20B4	D	domestic	220	55-220	13		15		4.41	2.21	-5.82			40	
9S3E34H3	SM	ag. and domestic	200	112-135; 178-184	24		28		7.59	1.44	-7.78		nd	44	
9S3E26J8	SM	domestic	175	135-175	55		63		8.47	2.59	-6.47		nd	60	
10S3E24H4	SM	domestic	200	85-180	17		19		5.05	3.57	-5.86		nd	16	
10S4E17E3	SM	domestic	200	180-200	37		41		10.08	3.24	-5.91		nd	43	
9S3E36B06	SM	domestic		185-225	27	32		nd	6.91	2.85	-6.21		nd	70	
10S3E01N1	S	monitoring	30	10-30	62		72		7.37	0.14	-5.75		nd	34	na - interference
11S4E05K10	S	monitoring	35.5	10-35	97		140		6.71	-0.38	-5.44		nd	33	na - interference
10S4E07K6	AF	domestic	237	187-237	22		24		8.41	1.95	-6.23			46	na - interference
10S4E07E33	AF	domestic	228	180-228	38		24		3.72	2.52	-5.88			34	<1
10S3E18J1	BK	domestic			0.05	1.2		nd	8.43	insuff. N	-5.36	0.9	nd	40	
9S3E31G5	BK	domestic	55	20-30; 45-55	0.9	2.5		nd	0.71	insuff. N	-4.82	na	nd	21	
				Detection Limits:	N/A	0.1	0.04*	0.1	N/A	N/A	N/A	0.5	1*	0.5	N/A

E = Example Wells
T = Trend Wells
F = Food Processor
SDP = Sewage Disposal Pits
STP = Gilroy Sewage Treatment Plant
W = Winery

D = Dairy
SM = San Martin Special Use Area
S = Shallow Monitoring Wells
AF = Agricultural Field
BK = Background area

All results reported in mg/L as the analyte (Nitrate as Nitrate, etc.)
nd = not detected
na = not analyzed
blank spaces = not collected
see text and appendices for units of 15N and 18O analyses

= results originally reported as Nitrogen (x 4.5 = as Nitrate)
* = detection limit when reported as Nitrogen
N/A = Not applicable
Dissolved Ox. originally reported as O2 % (O2% x .0914 = mg/L)

TABLE 5

Sample Results - Sampling Round 2 (February/March 1994)

Well I.D.	Well Purpose	Well Type	Reported Depth (feet)	Reported Screen(s) (feet bgs)	Nitrate # (Illinois)	Nitrate # (C & T)	Nitrite ^	Dissolved Ox.	Delta 15-N	Delta 18-O	TKN	Ammonia	Chloride	Total Coliform (MPN / 100 mL)	Fecal Coliform (MPN / 100 mL)	E-Coli (MPN / 100 mL)
10S3E01E2	E	domestic	250		3.3	86	nd	14.1	-13.09	-6.84			39			
10S4E18J1	E	domestic	180		32	32	nd	8.6	2.98	-5.02			40			
10S4E34L5	E	ag. and domestic	163		0.77	81	nd	9.8	-11.67	-5.74			60			
9S3E36D4	T	domestic			33	39; 38	nd; nd	6.4	-1.89	-5.82			32; 34			
10S4E17F1	T	domestic	360	240-360	0.86	2.7	nd	8.6	3.44	-6.24			40			
10S4E18G2	T	agricultural	130		29	30	nd	2.8	3.22	-6.26			30			
10S3E02C6	F	domestic	200	140-200	19	23	nd	7.4	.14	-7.12			60			
10S3E02L1	F	domestic	187		28	33	nd	6.8	3.50	-5.50			26			
9S3E36B7	SDP	domestic	225	165-225	1.1	33; 33	nd; nd	8.2	-5.88	-5.87			60			
9S3E36C3	SDP	domestic	220	100-120; 140-160; 180-220	1.6	99	nd	9.23	-5.79	-5.68			110			
11S4E09E1	STP	domestic	400	130-210; 250-310; 350-390	4.2	72	nd	9.8	-11.60	-5.49	nd	nd	26			
11S4E16R2	STP	agricultural	480	270-320; 340-360; 450-470	0.0	26	0.69	3.6	insuff. N	-5.52	nd	nd	60			
10S3E11D10	W	ag. and domestic	181	80-100; 121-141; 161-181	3.0	43	nd		-10.26	-5.44			27			
10S3E12N13	W	muni. and indust.	126	116-126	6.1	8.1	nd	4.62	3.18	-5.14			22			
10S3E12M10	W	muni. and indust.	200	120-200	4.3	25	nd	6.6	-5.58	-6.27			14			
10S4E17M10	D	domestic	210	80-210	2.3	33	nd	8.4	-9.36	-6.27			32			
10S4E20B4	D	domestic	220	55-220	16	18	nd	2.9	2.24	-6.14			40			
9S3E34H3	SM	ag. and domestic	200	112-135; 178-184	24	29	nd	6.6	-.09	-6.42		nd	41			
9S3E26J8	SM	domestic	175	135-175	3.2	68	nd	10.8	-8.20	-6.21		nd	60			
10S3E24H4	SM	domestic	200	85-180	17	21	nd	5.4	2.91	-5.22		nd	15			
10S4E17E3	SM	domestic	200	180-200	36	42	nd	10.3	1.43	-5.87		nd	44			
9S3E36B06	SM	domestic		185-225	1.0	33	nd	8.0	-8.79	-6.09		nd	50			
10S3E01N1	S	monitoring	30	10-30	4.5	99	nd	8.0	-12.44	-6.17		nd	38			
11S4E05K10	S	monitoring	35.5	10-35	1.7	140	nd	7.0	-11.30	-5.16		nd	29	16.1	5.1	2.2
10S4E07K6	AF	domestic	237	187-237	2.1	27	nd	9.6	-10.36	-6.49		nd	39	1.1	1.1	1.1
10S4E07E33	AF	domestic	228	180-228	3.1	50	nd	9.2	-10.82	-6.91			27	2	<1.1	<1.1
10S3E18J1	BK	domestic			.23	1.7	nd	13.16	0.13	-5.02			9	<1.1	<1.1	<1.1
9S3E31G5	BK	domestic	55	20-30; 45-55	0.0	5.0	nd	7.8	insuff. N	-4.68	nd	nd; nd	20; 20			
				Detection Limits for well samples:	N/A	0.04*	0.02*	N/A	N/A	N/A	1	1*	0.5 or 1	N/A	N/A	N/A
	Rainwater					4.0	nd				nd	nd				
				Detection Limits for rain sample:		2.2	1.6				1	1*				

E = Example Wells
T = Trend Wells
F = Food Processor
SDP = Sewage Disposal Pits
STP = Gilroy Sewage Treatment Plant
W = Winery

D = Dairy
SM = San Martin Special Use Area
S = Shallow Monitoring Wells
A = Agricultural Field
BK = Background area

All results reported in mg/L as the analyte (Nitrate as Nitrate, etc.)
nd = not detected
na = not analyzed
blank spaces = not collected
see text and appendices for units of 15N and 18O analyses

= results originally reported as Nitrogen (x 4.5 = as Nitrate)
^ = results originally reported as Nitrogen (x 3.3 = as Nitrite)
* = detection limit when reported as Nitrogen
N/A = Not applicable
2 results in same box indicate duplicate sample analysis

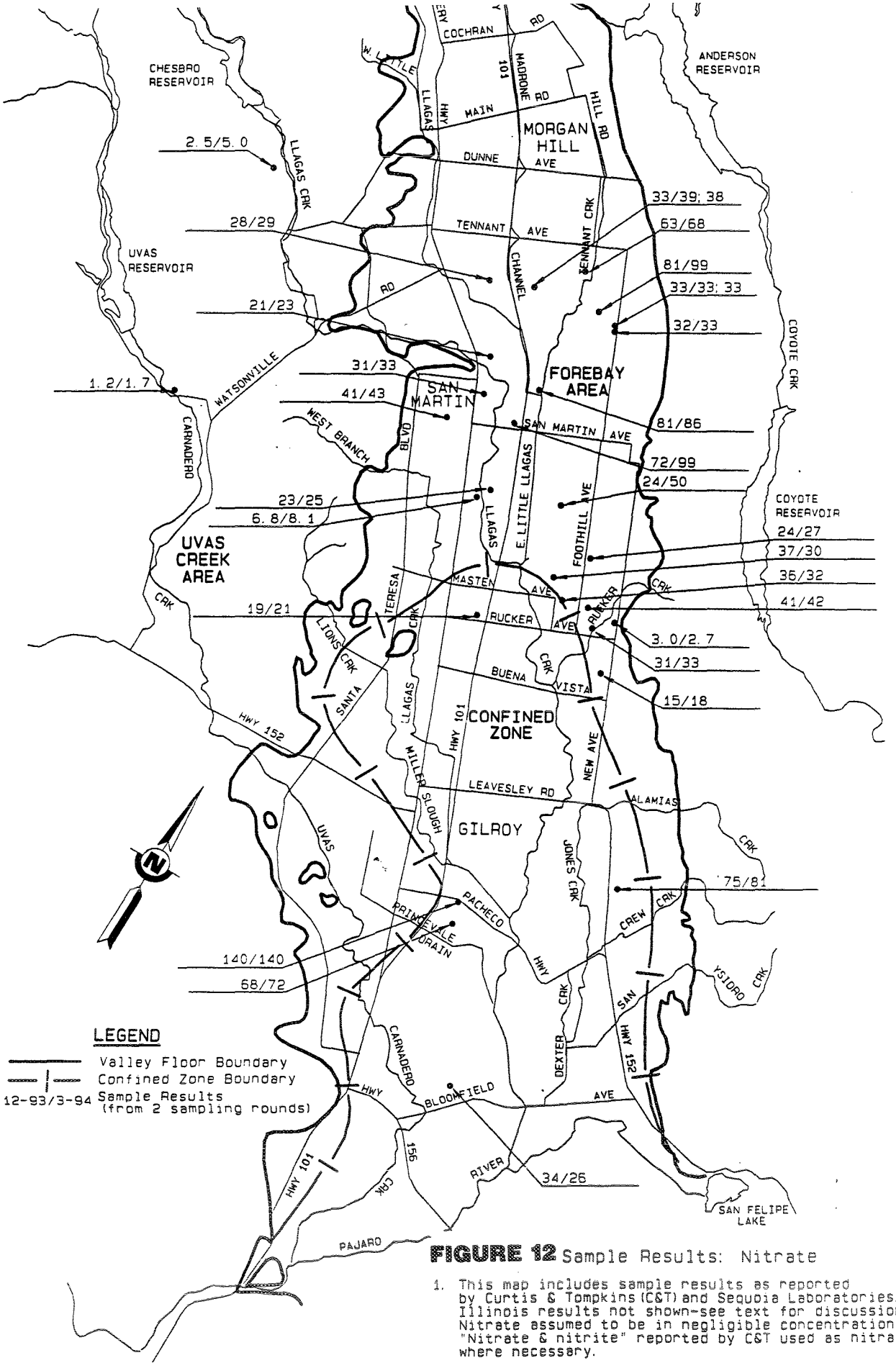


FIGURE 12 Sample Results: Nitrate

1. This map includes sample results as reported by Curtis & Tompkins (C&T) and Sequoia Laboratories. Illinois results not shown-see text for discussion. Nitrate assumed to be in negligible concentrations; "Nitrate & nitrite" reported by C&T used as nitrate where necessary.
2. All results in mg/L as nitrate.
3. Two results for one date indicate duplicate sample analysis.

Trend Analysis

Our sampling data appeared to support the generally increasing trend of nitrates we saw in the historical data review phase of the study; the results fell within the ranges of historical data. When evaluating the data in more detail, nitrate concentration trends in our selected wells did vary. Sampling results from half of the wells clearly showed a generally increasing trend. Samples from one "example" well[2] were much higher than previously observed concentrations, while nitrate concentrations from two other wells were below the historical trend. Trends seen in these two wells are not necessarily representative of nitrate trends throughout the study area. Graphs depicting our trend analysis are shown in Figures 13 through 18.

Comparison of results from the trend wells with results from other nearby wells helps to confirm the hypothesis that nitrate concentrations above the MCLs occur in Llagas Basin in numerous localized areas, rather than throughout the entire basin. A review of Figure 12 shows that wells producing water with high nitrate concentrations are often situated relatively close to those producing less contaminated water. This situation may also be due to a difference in screened interval allowing water intake from different aquifers. Plumes or large areal extents of nitrate-contaminated groundwater are not evident from our recent sampling data, or from historical data. Nitrate contamination in the study area likely exists in numerous localized, and possibly transient, "hot" spots, rather than basin-wide. Sources which contribute nitrate on an intermittent basis may create this phenomenon. The wells used in our sampling program are likely completed in just a fraction of the "hot" spots, both spacially and vertically.

Supplementary Analytes

Supplementary analyte results provided us with the following information:

Chloride

Chloride is associated with various sources such as septic tanks and potassium chloride fertilizer. Evaluation of chloride concentrations in conjunction with nitrate concentrations suggest that nitrates and chlorides do not have the same major sources. Suspected sources cannot be ruled out, however, as we did not fully investigate chloride patterns in the study area; such investigation was beyond the scope of this study.

Nitrite, Ammonia, and TKN

Nitrite, ammonia, and TKN are transitory products of the mineralization and nitrification processes. Analysis of these constituents may indicate areas of direct source/groundwater interaction. These analytes were not expected to be detected; our results generally support this expectation.

[2]Only three of the six wells used to study nitrate trends during our nitrate data review phase were available for resampling during this phase of the study. These three wells are referred to as "example" wells. Three additional wells that were not part of the original six, but that had sufficient nitrate trend data, were used during the sample analysis phase of the study and are referred to as "trend" wells. Additional discussion is found in our "Sample Analysis"report dated May 1995.

Nitrate Trends in Well #10S4E17F1

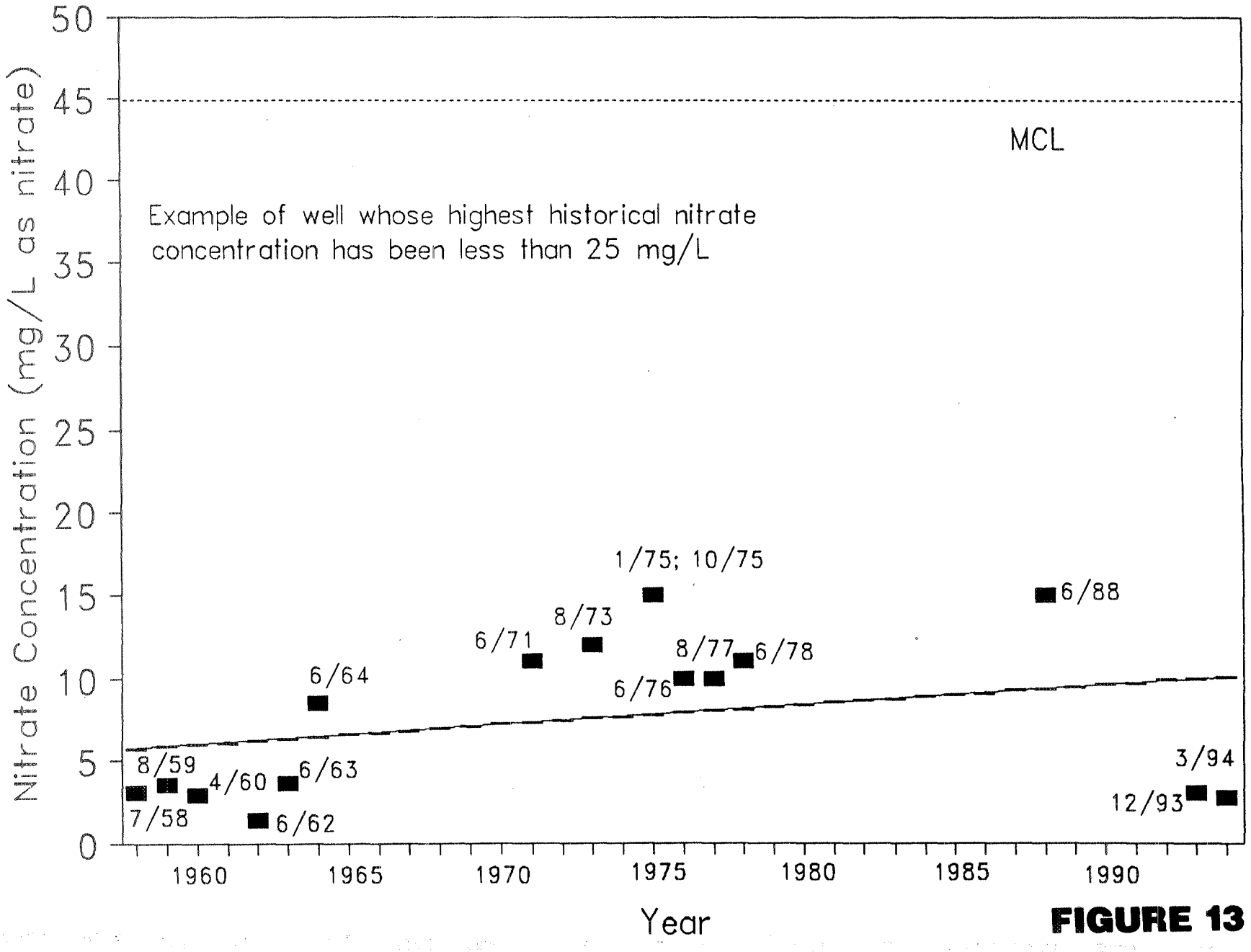


FIGURE 13

Nitrate Trends in Well #10S4E18J1

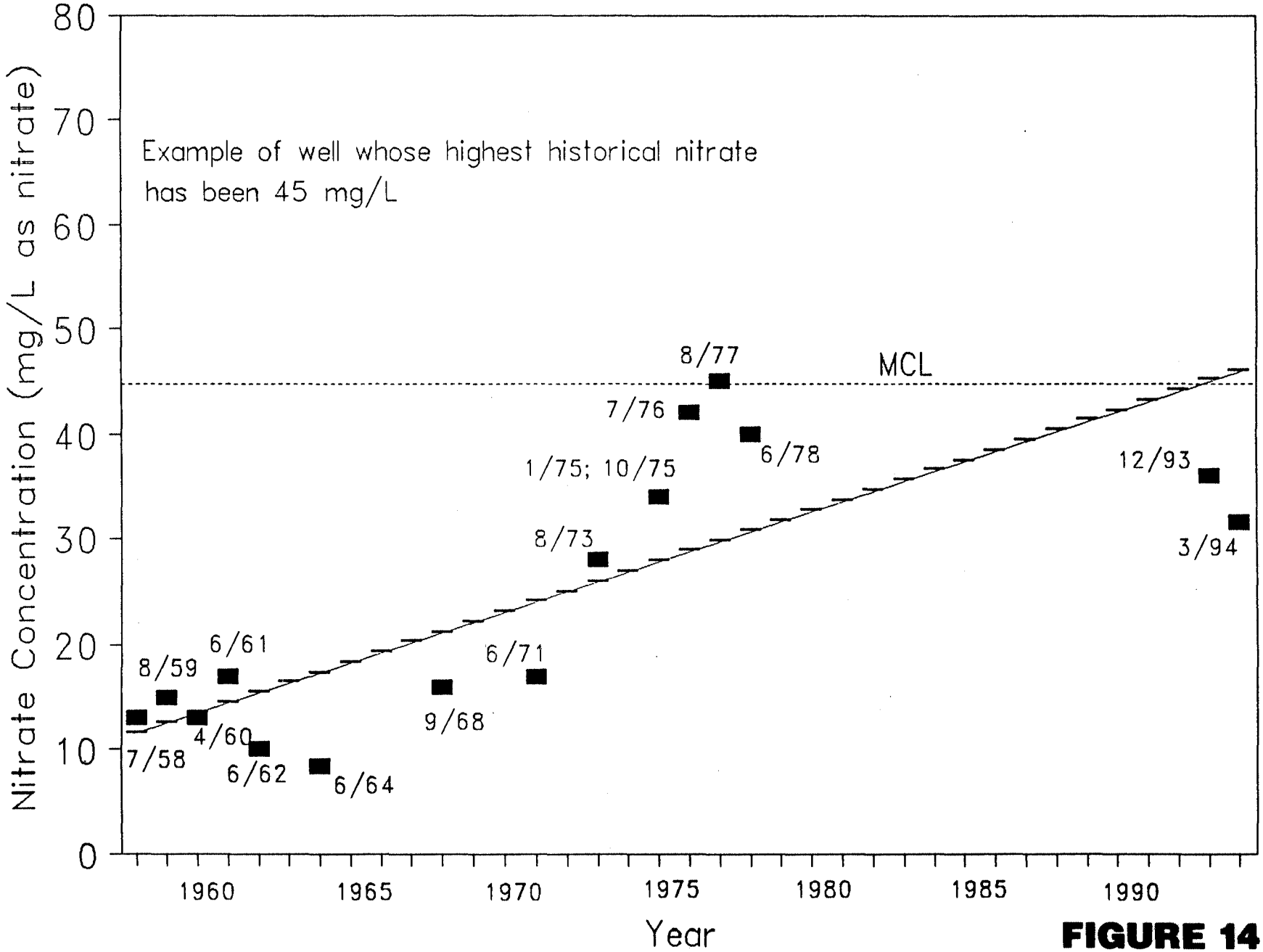


FIGURE 14

Nitrate Trends in Well #10S3E01E2

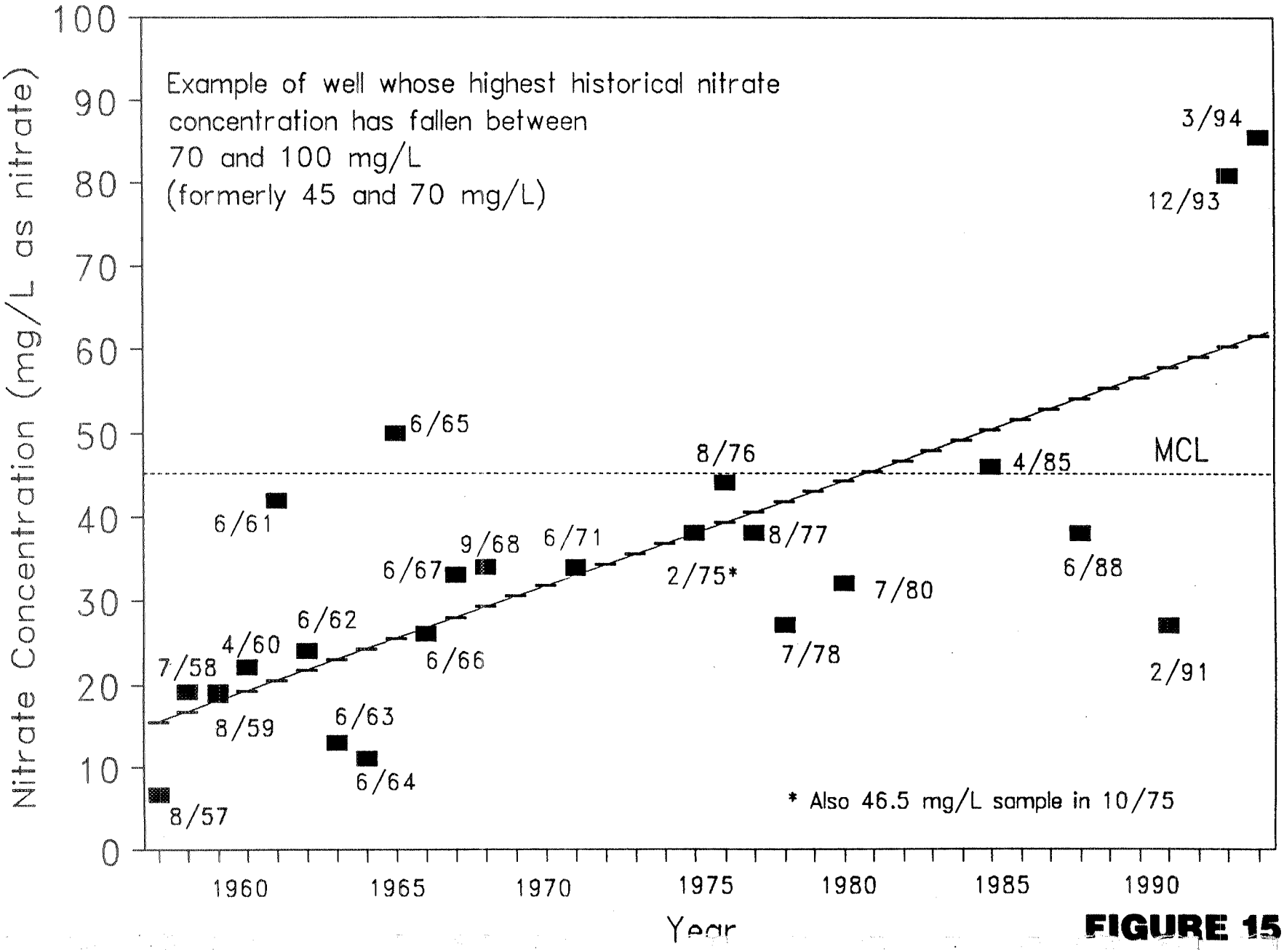


FIGURE 15

Nitrate Trends in Well #10S4E18G2

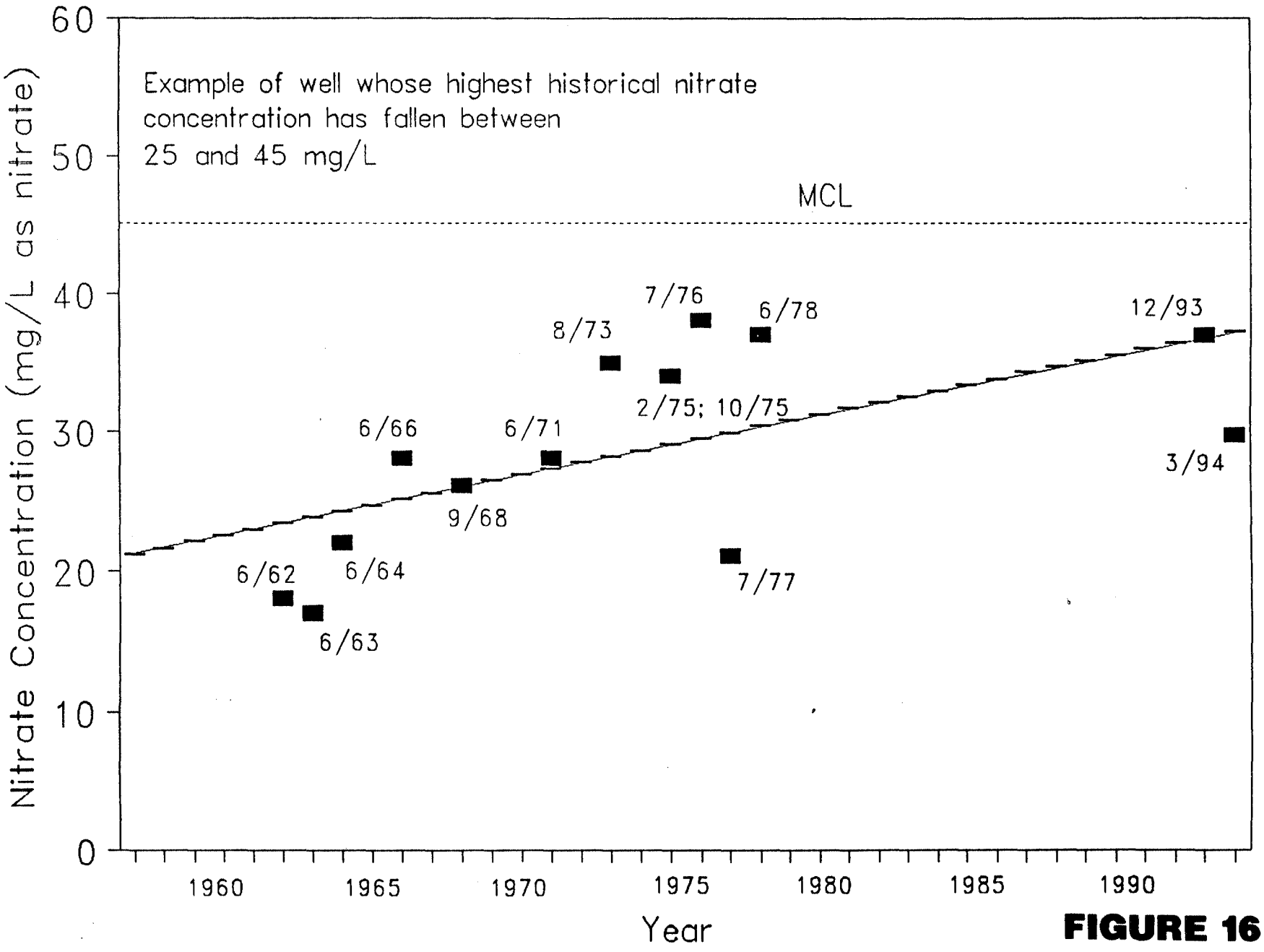


FIGURE 16

Nitrate Trends in Well #10S4E34L5

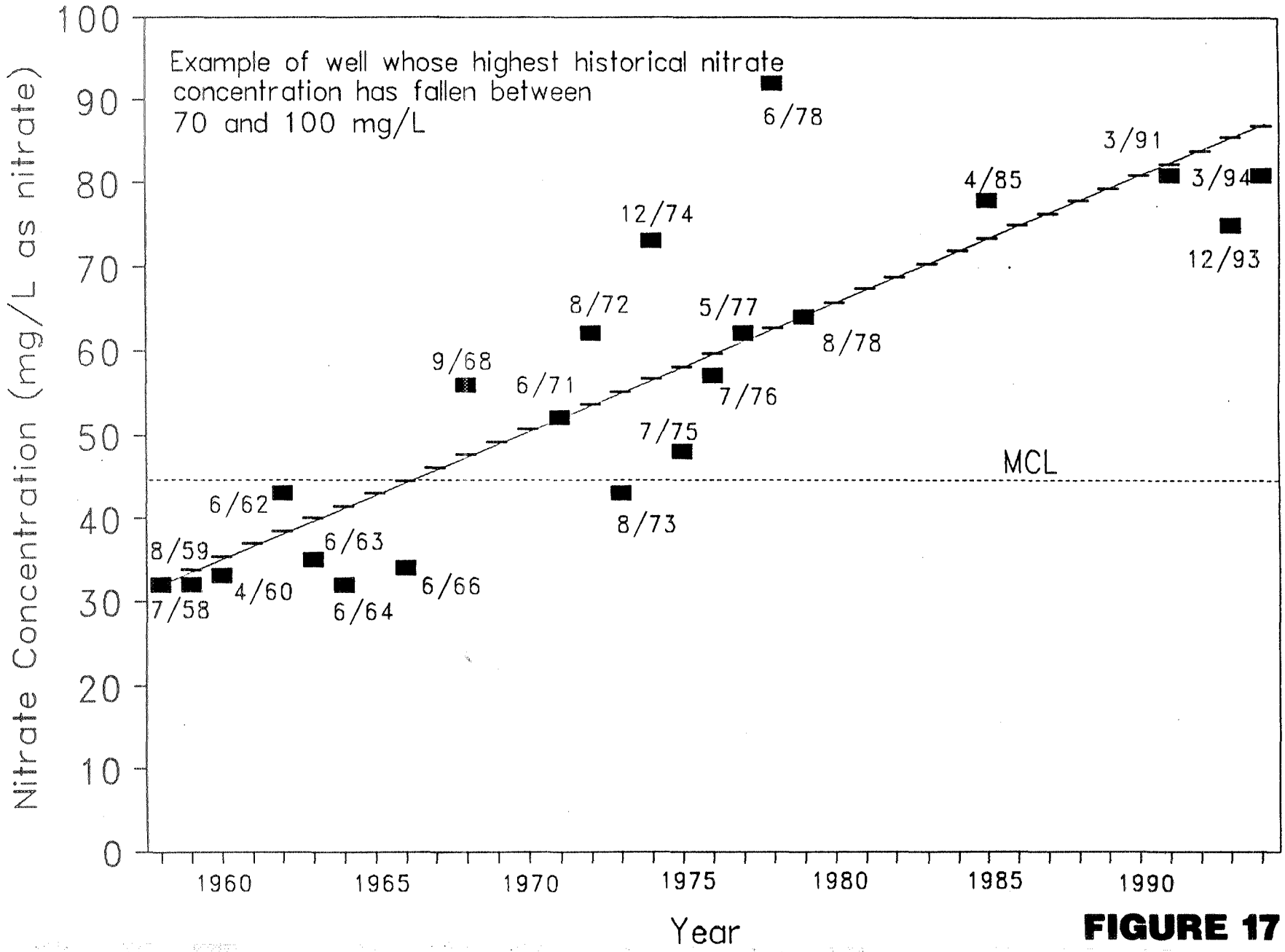


FIGURE 17

Nitrate Trends in Well #9S3E35D4

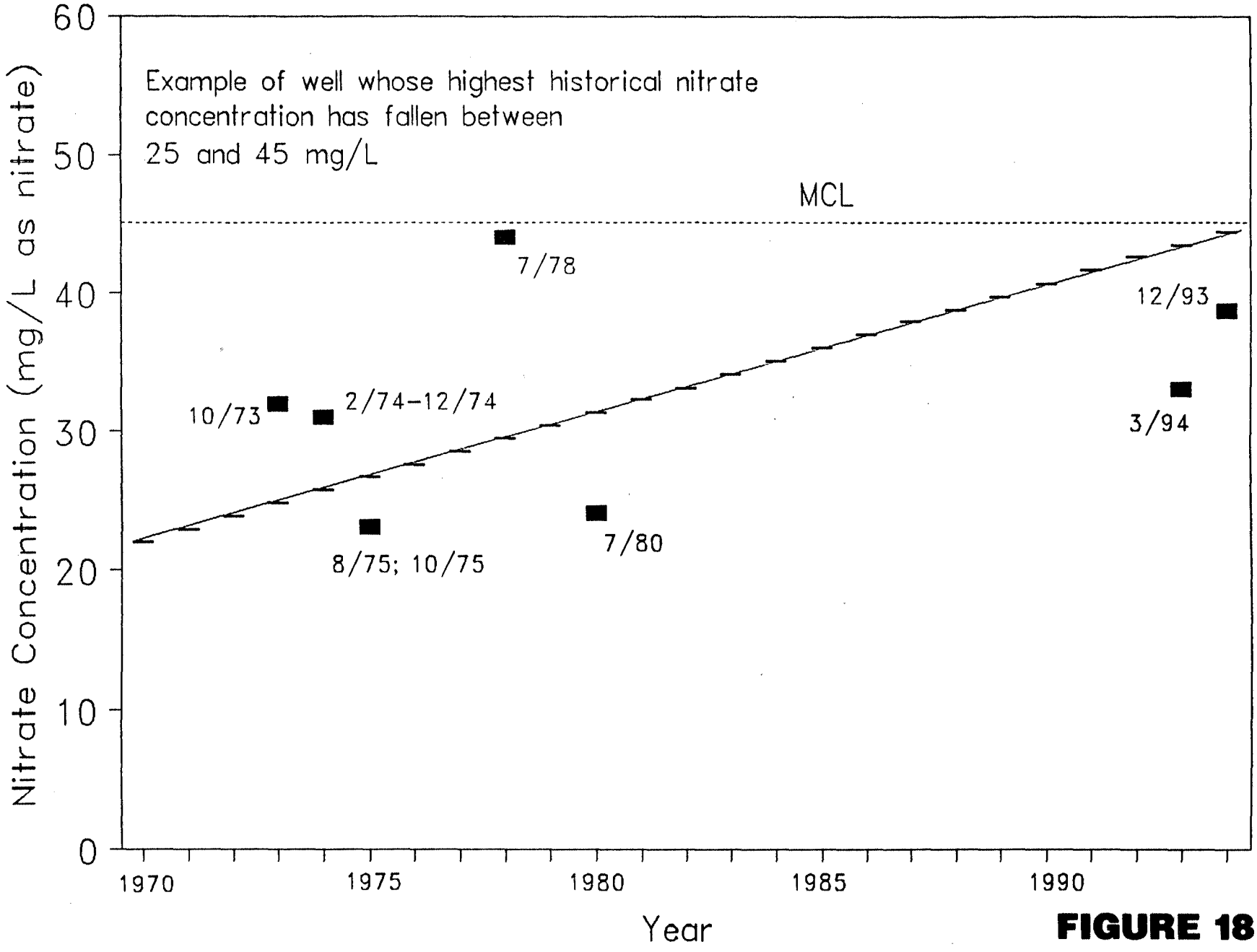


FIGURE 18

Stable Oxygen Isotope

Stable oxygen isotope results are often an indication of how long groundwater has been in contact with the aquifer formation. We evaluated stable oxygen isotope results in conjunction with nitrate concentrations and found no correlation, indicating that nitrate may be present in both young and old groundwater.

Dissolved Oxygen

Elevated dissolved oxygen readings may indicate that groundwater is receiving direct recharge from surface waters. Our readings are questionable due to unusually high levels in some instances. Also, we compared dissolved oxygen readings to the depth of the well and found no correlation.

Stable Nitrogen Isotope

The $\delta^{15}N$ analysis is a way of measuring the ratio of the two isotopes ^{15}N and ^{14}N in the nitrate of a groundwater sample. This ratio depends on the reactions that formed the nitrogen compound and the isotopic composition of its source. Please refer to Rolston, et al, 1994a, Appendix 1, for a full discussion of the stable nitrogen isotope analysis. Although analytes such as $\delta^{15}N$ have been used to identify nitrate sources in other studies, the lack of detailed hydrogeologic information and the lack of source and vadose zone sampling data currently preclude us from correlating our sampling results with specific nitrate sources. Despite limitations, a review of our nitrate and nitrogen isotope data indicates that fertilizer is the primary source of nitrates in groundwater in Llagas Basin. This finding supports the nitrogen loading data presented in our "Nitrate Source Area Identification" report.

Coliform

Like chloride, coliform may be used to determine nitrate sources, such as human and animal waste. Only a few wells were sampled for this analyte. Detectable quantities of coliform were detected in these wells. These results could indicate the presence of animal/human waste from direct infiltration and/or leaky sewer lines.

LIMITATIONS

With the data collected and the degree of analysis performed thus far, definitive conclusions regarding the *specific sources* of nitrate in the well water sampled as part of this study cannot be drawn. Although additional analytes such as $\delta^{15}N$ were used in our program, the fact that additional work such as vadose zone sampling and detailed hydrogeologic evaluation in the vicinity of each source was not performed precludes us from tracing nitrates in groundwater back to specific source areas or facilities (Rolston, et al., 1994a and b). Nitrates present in any given well may originate from a mix of two or more sources.

The relationship of these sources to contaminated wells may not be readily apparent from merely viewing regional maps and groundwater direction. Preferential migratory pathways and irregularities in local groundwater flow may exist and can cause a distant nitrate source to actually become a significant source. For example, conclusive identification of the specific contaminant source may still be difficult, even if nitrate concentration and the $\delta^{15}N$ value from a specific well are known. This is especially true in the

study area, which features complex subsurface geology, and multiple types and a high number of nitrate sources.

There are additional reasons for not attempting to identify nitrate sources using isotopic signatures alone (Rolston, et al., 1994). Denitrification can increase a nitrogen's $\delta^{15}N$ value, and, if not fully considered, may lead to erroneous interpretation of isotope results.

Also, the nitrate and $\delta^{15}N$ results from the University of Illinois at Urbana-Campaign (UIUC) for samples collected on March 2 and 7, 1994, were not used for evaluation during this phase of the study. No errors were found associated with any of the analyses, except for the March 2 and 7 samples which were sent to UIUC. Therefore, nearly all of the data collected during our two sampling rounds was used during data evaluation. Any evaluations of $\delta^{15}N$ results during this phase of the study, only incorporate results from the December sampling event. Although not all of the March results are suspect, we did not want to compare a single result from a well with an average of two results from another well.

VIII. NITRATE MANAGEMENT PLAN DEVELOPMENT

This portion of the report describes the approach we used to develop our final set of nitrate management recommendations. Prior to selecting our recommendations, we performed the following: set goals for developing and selecting our recommendations; evaluated technical information from previous portions of our study; researched and evaluated existing institutional mechanisms; conducted brainstorming sessions with our TAC; and considered resources, timeframes and budget for implementation of the nitrate management recommendations.

GOAL SETTING

We had four goals to meet while developing our nitrate management recommendations. Our first goal was to involve the public throughout development. We achieved this goal by involving the public throughout the course of the study, especially during the nitrate management recommendation review phase. The public provided input during public workshops, TAC meetings, District Agricultural Water Advisory Committee meetings, Water Retailer Agencies Groundwater Subcommittee meetings, District Board meetings, and special interest group meetings. We also made ourselves available to answer any questions and receive comments via phone calls and correspondence.

Our second goal was to develop recommendations with a high degree of ease of implementation. This goal assisted us in narrowing down our list of alternatives. Several methods of preventing exposure to nitrates, reducing nitrogen loading, or monitoring nitrate occurrence may have theoretically been effective, but were simply not practical to implement given the constraints of the size and population of the study area, and the costs associated with the particular method(s).

Our third goal, which helped to focus our final list of recommendations, was public acceptance. Since the nitrate management recommendations presented in this report are recommendations that require community participation, it was essential to obtain public buy-in.

Our fourth goal was to protect groundwater quality. The people of the southern portion of Santa Clara County rely solely on groundwater as a source for their drinking water supply. Our nitrate management alternatives were rated on the basis of their relative contributions to groundwater quality. For example, we excluded methods which may have been relatively inexpensive, and acceptable to everyone involved, but would most likely offer only a negligible water quality benefit.

TECHNICAL INFORMATION

Our final set of nitrate management recommendations were developed based predominantly on information collected during previous phases of this study. However, we researched and used other studies and nitrate management plans developed in other parts of the country to create and finalize our recommendations.

REVIEW OF EXISTING INSTITUTIONAL MECHANISMS

During the development of our nitrate management recommendations, we reviewed existing institutional mechanisms which either directly or indirectly affect the discharge of nitrogenous compounds to the soil and groundwater of Llagas Basin. Our review of institutional mechanisms included review of laws,

policies, ordinances, and other requirements established by governmental agencies. The following paragraphs describe those institutional mechanisms in current use which we identified as having an effect on nitrate contamination of groundwater. The institutional mechanisms have been grouped into two categories: overall institutional mechanisms and those institutional mechanisms specifically related to the sources we identified in our "Nitrate Source Area Identification" report dated December 1994.

Overall Institutional Mechanisms

The following paragraphs discuss legislative mechanisms which are in current use and which pertain to general groundwater quality issues and standards.

The Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Act of California (Porter-Cologne) consisting of Sections 13000-14958 of the Water Code, regulates quality of the state's surface and groundwater; governs National Pollution Discharge Elimination System (NPDES) programs pursuant to the Federal Clean Water Act, and authorizes the State Water Resources Control Board to order Corrective Action to cleanup hazardous contamination. The principle implementing agencies consist of the State Board and the Regional Water Quality Control Boards.

Water Quality Control Plan—Central Coast Region

The Central Coast Regional Water Quality Control Board (Regional Board), with State Board concurrence, adopts Water Quality Control Plans, also known as Basin Plans pursuant to Porter-Cologne, which establish water quality objectives and discharge effluent limitations for both surface and groundwater.

As promulgated by the Regional Board's Basin Plan and Porter-Cologne, the Regional Board issues Waste Discharge Requirements (WDRs) for facilities which produce significant amounts of waste. However, the Regional Board can also regulate waste management of any waste discharger, regardless of size by requiring waste discharge permits or granting a waiver with the implementation of best management practices. Specific requirements outlined in the WDRs for various dischargers are discussed in more detail below.

Drinking Water Standards and Advisories

The Federal Safe Drinking Water Act, 42 U.S.C., ref. 300f-300j-11, particularly 40 CFR 141, 142, and 143 provides for national primary, interim, and secondary drinking water regulations. The Act establishes Federal standards for drinking water and provides for state enforcement. The principle implementing agencies are the EPA, State of California, Department of Health Services Office of Drinking Water (DHS). Individual states use state environmental regulations to develop more stringent drinking water standards than those set by the Federal Safe Drinking Water Act. For example, California uses the California Code of Regulations, Title 22, Division 4, Chapter 15 for its drinking water standards.

When nitrate concentrations above safe drinking water levels are reported to the appropriate agency, officials may recommend blending the highly concentrated nitrate water with low concentrated nitrate water, or treating that water to meet water quality standards. If these

alternatives are too costly for the well owner, the well owner may choose to shut the well down altogether.

Federal and state drinking water regulations for nitrate in groundwater have been exceeded in Gilroy and Morgan Hill. The cities of Morgan Hill and Gilroy have shutdown municipal wells due to this. Morgan Hill has further addressed the issue by blending the water as discussed above (personal communication with city personnel, 1995).

Groundwater Quality Monitoring Requirements

A revision to the Santa Clara County Code, Division B11, Chapter VI A, Ordinance number NS517.47, on groundwater sampling, resulted in the elimination of a requirement to sample privately-owned wells when a piece of property changes owners. The new ordinance number, NS517.60, now states that groundwater sampling by property owners is voluntary when there is a change in ownership. The only sampling required of a property owner is prior to receiving water system clearance for building permits. This requirement is found in ordinance number NS517.41 (personal communication with Santa Clara County, Department of Environmental Health staff, 1995).

Remediation Requirements

The Regional Board oversees cleanup of sites with nitrate pollution. Under Section 13304 of Porter-Cologne, regional boards (including Central Coast Regional Water Quality Control Board) are authorized to issue cleanup or abatement orders (remediation). Any person who has discharged, discharges, permits, causes, or threatens to cause/permit a condition of pollution or nuisance shall upon order by a regional board, cleanup such waste or abate the effects thereof or take other necessary remedial action(s). Upon failure of any person to comply with such cleanup and abatement order, the Attorney General can intervene and develop a prohibitory or mandatory injunction. Section 13224 authorizes each regional board to issue policy statements relating to any water quality matter within its jurisdiction.

Graywater Reuse Guidelines and Ordinances

In 1992, Governor Wilson signed into law AB 3518, adding Chapter 22 to Division 7 of the Water Code and directing the State Department of Water Resources (DWR) to adopt standards for the residential use of graywater for subsurface irrigation. In March 1994, DWR adopted the California Graywater Standards as Appendix J, Graywater Systems for Single Family Dwellings, of the California Plumbing Code. These standards also comprise Appendix G of the 1994 Uniform Plumbing Code (UPC). Adoption of a UPC appendix is at the discretion of individual jurisdictions, i.e., cities and counties.

More recently, in October 1995, Governor Wilson signed into law AB 313, which amends Chapter 22 of Division 7 of the Water Code, relating to graywater. The bill revises the definition of graywater by removing references to single family residences and households. It directs DWR to adopt standards accordingly, by January 1, 1997, for the installation of graywater systems, ". . . for subsurface irrigation and other safe uses." (Legislative Counsel's Digest)

Nonpoint Source Institutional Mechanisms

The following paragraphs address both general nonpoint source requirements as well as institutional mechanisms associated with each of the nonpoint sources of nitrate we identified in our "Nitrate Source Area Identification" report dated December 1994.

Nonpoint Source Management Plan

The Regional Board adopted the State Board's 1988 Nonpoint Source Management Plan as part of their Basin Plan in 1994. This plan outlines a step-wise approach to address nonpoint source management. These steps generally include: (1) voluntary implementation of best management practices (BMPs), (2) enforcement of best management practices by waiving adoption of WDRs on condition that dischargers comply with BMPs or by entering into management agency agreements with other agencies who have the authority to enforce BMPs, and (3) adoption of effluent limitations. (personal communication with Central Coast Regional Board staff, 1995; Regional Board Resolution 95-04).

Agricultural Lands Fertilized By Commercial Fertilizer

Based on conversations with Regional Board staff, the Santa Clara County Agricultural Commissioner, Department of Pesticide Regulation staff, Food and Drug Administration staff, and California Fertilizer Association staff (personal communication, 1995), institutional mechanisms which specifically regulate application of commercial fertilizer to agricultural lands do not exist.

The California Fertilizer Association has issued guidelines to assist dealers, managers, and all other persons in the preparation and amendment of water control plans and WDRs for the protection of water quality with respect to management of fertilizers at facilities. (California Fertilizer Association, 1988).

The 1980 Santa Clara County General Plan (General Plan) designates agricultural lands as either large-scale or medium-scale. The County's zoning ordinance reflects this and further defines the size of these lands. Large-scale agricultural lands have a minimum of 40 acres; small-scale agricultural lands have a minimum of 20 acres (personal communication with Santa Clara County—Department of Planning and Development staff, 1995).

Manure Fertilizer Application

Based on conversations with Regional Board staff, the Santa Clara County Agricultural Commissioner, Department of Pesticide Regulation staff, Food and Drug Administration staff, and California Fertilizer Association staff (personal communication, 1995), institutional mechanisms which specifically regulate application of manure fertilizer to agricultural lands do not exist.

Other Fertilized Areas

Based on conversations with Regional Board staff, the Santa Clara County Agricultural Commissioner, Department of Pesticide Regulation staff, Food and Drug Administration staff, and California Fertilizer Association staff (personal communication, 1995), institutional mechanisms which specifically address other fertilized areas such as golf courses and lawns

do not exist. However, the Santa Clara County Planning Commission is in the process of developing Environmental/Design Guidelines for Golf Courses. These guidelines specifically address the storage and use of fertilizers, as wells as preparing pre- and post-construction monitoring reports for surface and groundwater quality to appropriate agencies.

Septic Tank Areas

The County's Private Sewage Disposal System Ordinance, number NS517.42, sets forth a minimum allowable distance from septic tanks to water wells, requires a minimum distance from septic systems to groundwater, and places requirements on soil permeability at septic system locations. This ordinance requires septic systems to be located no closer than 100 feet from water supply wells, and have specific requirements for depth of soil between the leach field and groundwater, depending on the percolation rate of the soil.

Septic tank ordinances were primarily written to protect against nuisance conditions from septic systems, to promote trouble-free operation and maintenance of the systems, and to protect against subsurface bacteriological contamination. Although these mechanisms help to protect water quality from some types of pollution, they do not prevent significant concentrations of nitrate from leaching to groundwater.

The County General Plan limits the average newly created parcel size for rural residential land uses, which are normally served by septic systems, to a 5-acre minimum. Many older parcels are served by on-site disposal systems and are less than 5 acres. For such pre-existing lots, County Environmental Health performs an evaluation of the use of on-site disposal systems in relation to the parcel size. (personal communication with Santa Clara County—Department of Planning and Development staff, 1995.)

Rainwater

Federal regulations define storm water point source discharges subject to the NPDES program (40 Code of Federal Regulations 122.26) On behalf of the EPA, the Regional Board may require National Pollution Discharge Elimination System permits from a storm water point source covering all conveyances part of that storm water discharge (Central Coast Basin Plan, 1989).

Natural Nonpoint Sources

Based on our review of existing regulations we are unaware of any institutional mechanisms which specifically address other natural nonpoint sources, such as soil organic matter of crop lands and natural areas of grass and forests.

Domestic Livestock

Currently, waste management for large-size animal confinement operations, such as dairies, egg farms, and feed lots, is regulated under the Regional Board's Basin Plan. However, the Regional Board can also regulate waste management of any waste discharger, including domestic livestock operations, regardless of operation size. In this case, the Regional Board may require waste discharge permits or grant a waiver with the implementation of best management practices.

Wells

The following paragraphs discuss institutional mechanisms affecting the contributions of nitrate loading from wells.

Sanitary Sealing of Water Wells

The District's "Standards for the Construction and Destruction of Wells and other Deep Excavations in Santa Clara County" (District Well Standards) requires that either 50 or 100 feet of sanitary seal material be installed on water wells drilled in the southern portion of the County. This requirement helps protect the well from infiltration of shallow contamination, insures the well will only be drawing water from deep water-bearing zones, and helps prevent vertical migration of contamination.

Chemigation

The District Well Standards require that backflow prevention devices be installed when the well is constructed. Also, the State of California Well Standards (Bulletin 74-90) also requires automatic devices which prevent backflow and/or back siphonage into a well.

Stormwater Infiltration Devices (Dry Wells)

The Resource Conservation and Recovery Act requires the registration of Class V injection wells which include dry wells and other infiltration devices. The District has a permitting program and oversees the construction of these devices (personal communication with District staff, 1995).

Proper Well Destruction

Improperly destroyed wells are vertical conduits that can contribute to the vertical migration of contamination to groundwater. Well destruction permits are required from the District to ensure proper well destructions consistent with District Well Standards.

Enhanced Treatment Systems

Based on conversations with County Environmental Health staff (personal communication, 1995), the County is in the process of developing a policy regarding enhanced treatment systems. This policy may include a monitoring program established by the two Regional Boards, and a reporting program.

Point Source Institutional Mechanisms

Most point source facilities identified in the study area are regulated by the Regional Board for proper management of wastes generated as discussed above. These point sources include animal confinement operation facilities (i.e. dairies, cattle feed lots, egg farms), food packing operations and wineries, cogeneration facilities, sewage treatment facilities, and mushroom farms and composting operations. Please note that not all agriculturally-related discharges are regulated. The Regional Board determines whether or not to regulate a given facility

within its jurisdiction based on the potential for the operations associated with that facility to degrade water quality (personal communication with Regional Board staff, 1995). The following paragraphs describe the requirements of point sources as set forth by the Basin Plan. It may appear that the requirements for several of these sources are identical; they are not. Each source type's requirements are slightly different and discussed in that manner.

Dairies

Dairies may be required via WDRs issued by the Regional Board to manage their wastes as follows: manure on the floors of corrals and barns are periodically scraped, temporarily stored at the manure storage area, and hauled off-site when dry; and washwater, stormwater runoff, and other wastewaters are disposed of at the retention ponds, disposal fields, and/or percolation reservoir.

In addition, dairies may be required to comply with a site specific monitoring and reporting program as well as the "Standard Provisions and Reporting Requirements for Waste Discharge Requirements: Dated January, 1984" (Standard Provisions). The site specific program involves (1) installation of monitoring wells up and downgradient of the disposal area and (2) sampling analyses of various pertinent chemicals including nitrate. According to the Standard Provisions, if additional data through monitoring or investigation indicates that compliance with the WDR is not adequately protecting groundwater, the Regional Board will review and revise the WDR as appropriate in order to ensure the protection of water quality.

Also, regulations exist concerning allowable number of cattle and/or other animals allowed per acre of dairy/feedlot land. In addition, in the mid-1980s, a number of dairies in the basin were bought out by the federal government. This may have removed several potential nitrate contributors from service. It has been mentioned that significant cattle populations are only present in the foothills of the southern portion of the County.

Cattle Feed Lots

Feed lots with 1,000 or more cattle (large-size) may be regulated under the Regional Board's Basin Plan and may be required to have a permit as a point source for waste discharge under the NPDES. Although the Regional Board's focus is on large-size feed lots, the Regional Board may also require discharge permits from any discharger, i.e. feed lot, regardless of size. Based on conversations with Regional Board (personal communication, 1994), no permits have been issued for feed lots—large or small.

Some of the specific requirements under a WDR for animal confinement operations are (1) to have adequate surface drainage to prevent continuous accumulation of surface waters in feed lots, (2) to be protected from overflow to stream channels during flood, and (3) to manage manure storage areas to minimize percolation of water into underlying soils.

Additionally, feed lots may be required to comply with a site specific monitoring and reporting program as well as the Standard Provision dated January, 1984. The site specific program typically involves monitoring of runoff from feed lots that includes periodic sampling of total organic nitrogen. According to the Standard Provisions, if additional data through monitoring or investigation indicates that compliance with the WDR is not

adequately protecting groundwater, the Regional Board will review and revise the WDR as appropriate in order to ensure the protection of water quality.

Also, regulations exist concerning allowable number of cattle and/or other animals allowed per acre of dairy/feedlot land.

Egg Farms

Similar to dairies and feed lots, large size egg farms may be required to obtain a permit for waste discharge from the Regional Board. Also, the Regional Board may require discharge permits from any egg farm regardless of their size. Under a WDR, the Regional Board regulates waste management practices of egg farms with specific policies pertaining to animal confinement operations. In addition, they may be required to comply with a site specific monitoring and reporting program as well as the Standard Provisions dated January, 1984. According to the Standard Provisions, if additional data through monitoring or investigation indicates that compliance with the WDR is not adequately protecting groundwater, the Regional Board will review and revise the WDR as appropriate in order to ensure the protection of water quality.

Food Packing Operations

Food packing facilities may be required under WDRs issued by the Regional Board to properly manage wastes generated. For example, food process wastewater is permitted to be discharged only to the designated disposal ponds and/or septic tanks/leach field system. Also, these packing facilities are required to maintain the discharge of wastes so that overflow, seepage, or bypass of wastewater discharge onto adjacent properties, or into drainageways, storm waters, or Llagas Creek does not occur.

In addition, food packing operations may be required to comply with a site specific monitoring and reporting program as well as the Standard Provisions, dated January, 1984. The site specific program involves (1) installation of monitoring wells up and downgradient of the disposal area and (2) sampling analyses of various pertinent chemicals including nitrate. According to the Standard Provisions, if additional data through monitoring or investigation indicates that compliance with the WDR is not adequately protecting groundwater, the Regional Board will review and revise the WDR as appropriate in order to ensure the protection of water quality.

Wineries

Wineries may be required to have either permits for waste discharge, or a waiver for waste discharge requirements from the Regional Board (including best management practices). Under the WDR, wineries may be required to comply with a site specific monitoring and reporting program as well as all items of the Standard Provisions, dated January, 1984. According to the standard Provisions, if additional data through monitoring or investigation indicates that compliance with the WDR is not adequately protecting groundwater, the Regional Board will review and revise the WDR as appropriate in order to ensure the protection of water quality.

Cogeneration Facilities

Cogeneration facilities may be required under WDRs issued by the Regional Board to properly manage wastes generated. For example, some facilities are permitted to discharge their wastes only to the designated wastewater disposal areas.

In addition, cogeneration facilities may be required to comply with a site specific monitoring and reporting program as well as the Standard Provisions, dated January, 1984. The site specific program involves (1) installation of monitoring wells up and downgradient of the disposal area and (2) sampling analyses of various pertinent chemical including nitrate. According to the Standard Provisions, if additional data through monitoring or investigation indicates that compliance with the WDR is not adequately protecting groundwater, the Regional Board will review and revise the WDR as appropriate in order to ensure the protection of water quality.

Sewage Treatment Facility

The sewage treatment facility in the study area is required under WDR issued by the Regional Board to properly manage wastes generated. This facility is prohibited from discharging its wastes to areas other than the designated domestic wastewater disposal ponds. Also, nitrate reported as nitrogen concentrations in the groundwater affected by the disposal area are not allowed to exceed 10 mg/L.

This facility is prohibited from discharging its wastes to areas other than the designated domestic disposal ponds. As required to comply with the Monitoring and Reporting Program No. 92-20, this facility has shallow monitoring wells installed within and in the immediate vicinity of the disposal ponds. Periodic samplings are conducted in the existing wells to assess impact of the discharge to groundwater.

Expansion is planned for the wastewater treatment plant in Gilroy which treats the sewage generated in the southern portion of the County. Reduction of nitrogen loading to Llagas Basin was one of the main design goals of the expansion. Currently, the effluent from the plant typically contains about 30 mg/L of total nitrogen. The expansion is designed to further nitrify and denitrify the water so it contains about 10 mg/L of total nitrogen at its discharge point to the disposal ponds. The plant maintains that 10 mg/L is a conservative estimate, and that 50 percent removal of total nitrogen will occur in the soil before the water reaches the groundwater table. The Basin Plan requires a groundwater quality standard of 5 mg/L. It appears that the wastewater treatment plant expansion will reduce nitrogen loading by about 67 percent as an ongoing nitrate source in the study area.

Sewage Disposal Pits

The County's Private Sewage Disposal System Ordinance, number NS517.42, specifically prohibits sewage disposal pits, cesspools, and seepage pits. The Basin Plan states that seepage pits should be utilized only after careful consideration of site suitability.

Mushroom Farms and Composting Operations

According to the Regional Board's Basin Plan, mushroom farm operations may be required to have a permit for their waste discharge. The Regional Board's policies regarding mushroom farm operations specifically prohibit discharge of compost leachates, washwater, or contaminated stormwater to areas other than the designated and approved areas for treatment, storage, and disposal, such as lined oxidation/evaporation ponds. Additionally, these farms and operations may be required to comply with a site specific monitoring and reporting program as well as the Standard Provision dated January, 1984. The site specific program involves collection of representative grab samples of effluent within the pond and analysis for dissolved oxygen. According to the Standard Provisions, if additional data through monitoring or investigation indicates that compliance with the WDR is not adequately protecting groundwater, the Regional Board will review and revise the WDR as appropriate in order to ensure the protection of water quality.

Greenhouse Operations

Based on conversations with Regional Board staff (personal communication, 1994), greenhouse operations in the southern portion of the County are currently unregulated. However, Regional Board staff have the option of regulating such operations via WDRs, if such operations pose a clear and direct threat to water quality.

IX. NITRATE MANAGEMENT ALTERNATIVES

As mentioned in earlier sections of this report, the TAC was instrumental in helping us create a list of nitrate management alternatives. During one of our TAC meetings, we facilitated a brainstorming session in which suggestions to manage nitrate contributions to Llagas Groundwater Basin were recorded. Subsequent TAC meetings further refined this list by discussing advantages and disadvantages of each alternative, comparing this list to our goals, and performing some subjective analysis based on knowledge and experience.

The results of our brainstorming session and our preliminary discussions of the advantages and disadvantages of each alternative are presented in Table 6. The alternatives were originally separated into three categories: potential preventative measures, well water treatment/nitrate control, and basin remediation.

After creating Table 6, each alternative was rated on the following goals: (1) water quality benefit; (2) ease of implementation; and (3) community acceptance. The goals were rated on a scale from 1 to 10, with 10 indicating a more favorable score. An overall score was also computed for each alternative. Rating results are shown in Table 7. Please note that the values in parentheses in the "Overall Score" column indicate the alternative's relative ranking based on its total overall score, with 1 being the most valuable alternative.

A list of the top ten recommendations was developed based on this numerical ranking. We recognized that in a couple of cases, an alternative received a fairly high score when its overall benefit to the basin-wide nitrate condition was negligible. The subjective analysis we performed following the numerical scoring essentially ruled out the graywater reuse policy reevaluation and the landfill leachate monitoring alternatives. The top ten recommended management recommendations following this ranking procedure are presented in Table 8.

We sent a rough draft of our nitrate management plan recommendations to each TAC member, and to each of the District's Agricultural Water Advisory Committee members for comment. Based on those comments and further evaluation of our top ten recommended management recommendations with respect to relative projected costs, we separated the recommendations into three categories: recommendations to reduce nitrate exposure, to reduce nitrate loading, and to monitor nitrate occurrence. A discussion of these recommendations can be found in the following section of this report.

TABLE 6
Alternatives for Nitrate Management[1]

Preventative Measures	Advantage	Input From	Disadvantage	Input From
Reevaluate Graywater Reuse Policy • Eliminating graywater reuse would possibly eliminate a potential nitrate source.	• Potentially eliminates household pollutants from entering soil/groundwater.	District[2]	• May discourage water conservation. • Graywater elimination would probably not significantly reduce nitrate loading because graywater is a relatively small nitrate contributor. • Political consistency would not be maintained.	District District Jack Muench
Promote Alternative On-Site Sewage Disposal Systems • Some alternative on-site sewage disposal systems can remove nitrate from effluent. Use of these systems would reduce nitrate loading to basin.	• Would remove most nitrate from septic tank effluent. • Cost would be borne by nitrate contributor.	District District	• Alternative systems may be more expensive than conventional systems. • May be difficult to replace existing systems because they may require larger areas. • EIR may be required to change current land use policy for residential developments. Would be costly for county to develop EIR. • Most alternative systems require extensive operation and maintenance. • May need monitoring. • Alternative systems tend to have more downtime. • May encourage further development, which may have other adverse effects such as increased traffic. • If system is not functioning properly, owner may choose not to complete maintenance. • May increase regulatory costs due to inspection and permitting. • Any alternative system must be acceptable to the Regional Boards.	District District/Hugh Graham Hugh Graham District District Hugh Graham Hugh Graham District District District

Preventative Measures	Advantage	Input From	Disadvantage	Input From
Initiate Leachate Monitoring for Septic Systems	• Would identify potential nitrate sources.	District	• Only monitors—doesn't remediate or eliminate problem.	District
• Monitoring would help identify nitrate sources so that they could be addressed.	• Would alert owner to a problem earlier to reduce cleanup costs.	District	• May not be needed as nitrate contribution from household can be estimated and discharge concentrations projected.	District
• Monitoring alone will **not** eliminate source or cleanup existing problem.			• May not be needed as nitrate contribution from household can be estimated and discharge concentrations projected.	District
			• Expensive due to installation costs for lysimeters or groundwater monitoring wells.	District
			• Monitoring costs.	District
Rewrite County Private Sewage Disposal Ordinance Concerning Amount of Septic Systems per Area Based on Nitrate Loading Potential	• Could reduce nitrate contributions from new residential development.	District	• Could inhibit new residential development.	District
• Limiting the amount of septic systems per area could limit overall nitrate loading to basin.	• Would not need EIR; may only need a negative declaration.	Hugh Graham		
Use Packaged Low-Capacity Wastewater Treatment Systems for Housing Developments and Neighborhoods	• Would control nitrate loading from septic tanks because packaged systems could control nitrate in effluent at a central location.	District	• Cost could inhibit new residential development.	District
• Elimination of individual on-site disposal systems would limit nitrate loading to basin.	• Developer could install when new development is installed.	District	• Coordinating existing on-site disposal system "tie in" would be difficult.	District
	• Would need waste discharge requirements from Regional Board.	District	• Potential ineffective removal of nitrates due to high operation and maintenance.	District
	• System operation and maintenance would be conducted by a trained and licensed technician.	District	• Would need waste discharge requirement from Regional Board.	District
	• More easily controlled discharge concentrations.	District	• May require licensed operators.	District
			• Regulatory costs.	Bill Cilker

TABLE 6
Alternatives for Nitrate Management[1]
(continued)

Preventative Measures	Advantage	Input From	Disadvantage	Input From
			• Same disadvantages as "Alternative On-Site Sewage Disposal System." The County considers packaged plants to be included in this category.	Hugh Graham
Additional Municipal Wastewater Treatment	• Would reduce or eliminate nitrate loading to groundwater via wastewater discharge. • Would provide additional treatment for septage—already required to be disposed of at local treatment plant.	District District	• Cost to augment treatment facility. • Monitoring costs to ensure effluent has been denitrified.	District District
Create Special District to Monitor Septic Systems • Could put more control on septic tank users to attempt to limit nitrate loading.	• Could aid in the control of nitrate loading from septic tanks.		• Increased regulatory costs.	District
Public Education	• Inexpensive. • May address a variety of potential sources. • Voluntary compliance. • Reduced regulatory costs.	District District District District	• May not address the largest nitrate sources. • Without enforcement may be ineffective. • Does not address nitrate already in soil and groundwater. • May have a "lag time" for effectiveness.	District District District District
Augment Well Sealing Standards for New Wells • Would aid in prevention of the rapid transport of nitrate to drinking water aquifers.	• May help stop rapid migration of nitrate to drinking water aquifers via wells.	District	• Will not stop vertical transport of nitrate in the long-term. • Will not stop long-term vertical migration to aquifers of nitrate from the soils. • Does not address existing wells which may be transporting nitrate.	District District District

TABLE 6
Alternatives for Nitrate Management[1]
(continued)

Preventative Measures	Advantage	Input From	Disadvantage	Input From
Require Replacement of Existing Wells Which are Determined to Aid Vertical Transport of Nitrates	• May help stop rapid migration of nitrate to drinking water aquifers via wells.	District	• Could be relatively expensive to well owners.	District
• Would aid in prevention of the rapid transport of nitrate to drinking water aquifers.	• Would protect well users from poor water quality from shallow aquifers.	District	• Well destruction is expensive with high potential for problems.	District
			• Increased regulatory costs because of increased need for well inspectors.	Bill Cilker
Determine Location of Improperly Destroyed Wells	• May aid in stopping rapid migration of nitrate to drinking water aquifers via improperly destroyed wells.	District	• May be difficult and costly to find old, improperly destroyed wells.	District
• Once wells are identified, they could be properly destroyed, thereby, limiting rapid vertical transport of nitrate to drinking water aquifers.				
Improve Identification of Wells When Getting a Building Permit	• Could identify more improperly destroyed or abandoned wells which could be properly destroyed.	District	• Would increase regulatory costs for inspectors, etc.	District
• More wells could be found and properly destroyed, thereby limiting the rapid vertical transport of nitrate to drinking water aquifers.				
Increase Monitoring Frequency in Private Wells	• Will identify which wells are above maximum contaminant levels (MCL) before health problems arise.	District	• Does not address polluted soil or groundwater—only identifies problem.	District
• Would help keep public from drinking high nitrate water and could identify problem areas.	• Early identification of contamination may help prevent the problem from increasing.	District	• Potentially expensive—depending on monitoring frequency.	District
			• Increase well owners operating costs.	District
Increased Regulation of Point Sources	• May stop "known" releases of nitrate.		• Increased regulatory costs.	District
• Could limit amount of nitrate that is discharged from each point source.	• Point sources are more readily identifiable than other sources; thus they are easier to control.	Bill Cilker	• Compliance costs may inhibit investment in area.	District

TABLE 6
Alternatives for Nitrate Management[1]
(continued)

Preventative Measures	Advantage	Input From	Disadvantage	Input From
	• Could easily encourage source reduction of point sources.	Hugh Graham	• Significant nitrate contribution may be through nonpoint sources and would not be affected.	District
Regulate Fertilizer Use (Amount, Type Application)	• May address a significant portion of nitrate loading.	District	• May have wide-spread economic impact on the agricultural community and community as a whole.	District
• Could stop overfertilization and nitrate loading to soil and groundwater.	• Low capital expenditure.	District	• Increased regulatory costs.	District
	• May save money for farmers who currently overfertilize.	District		
	• Farmers who don't comply could help pay for other management alternatives.	District		
	• Could be done as a "phased" approach with regulation occurring only if an education program fails.	District		
Monitor Landfill Leachate	• Will provide early detection of a potential nitrate contributor.	District	• Doesn't address nitrate loading.	District
• Could identify any nitrate problem emanating from landfill.			• Landfills may be a minor nitrate contributor so would have only limited effect.	District
• Pacheco Pass landfill.			• Landfills are already heavily monitored for constituents including nitrate.	Hugh Graham

TABLE 6
Alternatives for Nitrate Management[1]
(continued)

Water Treatment	Advantage	Input From	Disadvantage	Input From
Water Blending to Reduce Nitrate Levels in Drinking Water by Blending With Either Groundwater or Treated Surface Water	• Easily accomplished.	District	• Many wells in county are over 45 ppm MCLs.	SCVWD
• Would allow wells with high nitrate concentrations to continue to be used as water sources.	• Inexpensive.	District	• Doesn't address private wells or small water systems.	SCVWD
	• Could use water being currently imported to basin (San Felipe).	Bill Cilker	• Short-term alternative.	SCVWD
	• Inexpensive if existing infrastructures are used.	District	• Can be expensive if capital improvements are required for water conveyance.	SCVWD
	• Could use water from high nitrate wells for crops.	Bill Cilker	• May not be cost-effective (impact of water treatment plant and undetermined community support).	Jack Meunch
			• May be difficult to get water for blending.	SCVWD
Shut Down Wells Which Produce High Nitrate Water	• Stops potential health problems from high nitrate wells.	District	• Many wells in basin are over the 45 ppm MCL—may have to shut down significant number of wells.	SCVWD
• Would eliminate high nitrate wells from the water supply network.	• Relatively inexpensive if other water sources are readily available.	District	• Reduce available groundwater supply.	Bill Cilker
	• Easily accomplished.	District	• Stops the removal of contaminated water from the aquifer.	SCVWD
			• May be expensive to replace wells which have shut down.	SCVWD
Employ Alternative Water Supply for Basin	• Would not have to depend on Llagas basin water.	District	• High cost to develop alternative supply. • Would have to construct delivery system to supply current private well users.	SCVWD
• Would import in clean nitrate-free surface water to be used for drinking water.	• Nitrate issue managed jointly through groundwater and treated water.	District	• Would have to construct delivery system to supply current private well users.	SCVWD
	• Simplifies blending process.	Jack Muench	• Would have to construct delivery system to supply current private well users.	SCVWD
	• Greater flexibility for water supply.	Jack Muench		

TABLE 6
Alternatives for Nitrate Management[1]
(continued)

Water Treatment	Advantage	Input From	Disadvantage	Input From
	• Greater flexibility for water supply.	District		
	• Greater quantity and quality of water.	District		
	• Could continue to use groundwater from wells that have not been effected and supply water only to "hot spots."	District		
Point-of-Use Treatment at Wellhead or Tap	• Would only need to treat wells over MCLs.	District		
• Would attempt to remove nitrate from water with high nitrate concentrations.	• Would not have to "tie in" all water users.	District	• Doesn't address nitrate loading.	SCVWD
			• Only users with effected wells would be impacted.	SCVWD
			• Short-term capital costs to users.	SCVWD
			• Long-term operation and maintenance costs.	Glenn Hildebrand
			• Monitoring costs.	SCVWD
			• Owners may not complete required operation and maintenance.	SCVWD
			• Users may have no incentive to keep treatment systems functioning if no infants are in home.	Glenn Hildebrand
Phase Out Use of Shallow Water Supply Wells	• Could rely on deeper, potentially uneffected zones for drinking water supply without cleaning up the shallow zones.	District	• Would be expensive to replace existing shallow wells with new, deeper wells.	SCVWD
• Water from deeper zones may not be impacted by nitrate contamination.			• Existing deep wells probably allow contamination to enter deeper zones.	

TABLE 6
Alternatives for Nitrate Management[1]
(continued)

Basin Remediation	Advantage	Input From	Disadvantage	Input From
Flush and Dilute Basin Using Groundwater Recharge	• May eliminate need for alternative management and treatment techniques.	District	• Relies on imported water.	SCVWD
• Would attempt to replace nitrate contaminated-groundwater with clean, nitrate-free water.	• May allow shut-down wells reactivate.	District	• Capital costs for building percolation ponds, etc.	SCVWD
	• Displaces nitrate contaminated water.	District	• May release nitrate from unidentified soil source to groundwater.	SCVWD
			• May take a very long time.	SCVWD
			• May promote accumulation of nitrate in basin.	SCVWD
			• Extensive studies would be required for proper siting.	SCVWD
			• Flushing results unclear—limited recharge sites.	SCVWD
			• Unknown reliability of water source for recharge ponds.	SCVWD
Site-Specific Soil Remediation	• Would remove nitrate source so that further groundwater degradation from source is halted.	District	• Expensive to remediate soil.	SCVWD
• Would attempt to remove nitrate from soil before it enters groundwater.			• May be difficult to remediate deeper soil pollution.	SCVWD
• Soil excavation.			• May just move contaminant from one point to another.	Edith Edie
• In-site bioremediation			• Benefit may not be worth cost to cleanup existing problems.	Edith Edie
Site-Specific Groundwater Remediation	• May help deal with "hot spots."	District	• Basin-wide problem would continue to exist.	SCVWD
• Would cleanup nitrate-contaminated water in areas where high concentrations are found.			• Doesn't address accumulated concentrations in soil.	SCVWD

TABLE 6
Alternatives for Nitrate Management[1]
(continued)

Basin Remediation	Advantage	Input From	Disadvantage	Input From
• Pump and treat. • In situ bioremediation			• Doesn't address nitrate source.	SCVWD
Site-Specific Interceptor Wells Which Provide Hydraulic Control • Would attempt to protect drinking water well fields from contaminated water.	• May protect important water supply wells.	District	• Does not address nitrate source. • Would be difficult to protect private water supply wells because they are so ubiquitous. • Would produce large quantities of water that may be contaminated with nitrate.	SCVWD SCVWD
Basin-Wide Groundwater Remediation—Groundwater Extraction and Treatment • Would attempt to cleanup any water in basin that is impacted by nitrates.	• Addresses groundwater problem.	District	• Very expensive. • May take a very long time. • Probably not feasible because extent of problem.	SCVWD SCVWD SCVWD

[1] The information in this table was a result of brainstorming sessions held during meetings with the Technical Advisory Committee (TAC). Please refer to "Chapter IX, Nitrate Management Alternatives" for more details.

[2] District refers to Santa Clara Valley Water District.

TABLE 7[1]
Nitrate Management Alternative—Selection Worksheet December 14, 1993

Alternatives	Water Quality Benefits[2]	Ease of Implementation[3]	Community Acceptance[2]	Overall Score[3, 4]
PREVENTIVE MEASURES				
Graywater reuse	1	6	5	12
Alternative sewage disposal systems (County EIR required)	3	1	3	7
Leachage monitoring	2	2	5	9
Revise current couhty septic tank ordinance nitrate loading potential	2	2	2	6
Package wastewater treatment systems (sequence batch reactor)	8	5	7	20 (5)
Additional wastewater treatment	4	10	8	22 (3)
Special district to monitor septci systems operations	2	2	2	6
Public education (combined with another alternative	7	8	10	25 (1)
Augment well sealing standards for new wells (protect deeper aquifers)	4	8	8	20 (5)
Replacement of existing wells with new standard wells	7	2	2	11
Find and properly destroy abandoned wells	3	1	5	9
Identify and destroy all abandoned wells as part of building permit	3	4	5	12
Increase monitoring in private wells	3	8	6	17 (9)
Increased regulation of point sources	9	8	5	22 (3)
Regulate fertilizer use	8	8	9	25 (1)
Monitor landfill leachate	1	10	9	20 (5)

Alternatives	Water Quality Benefits[2]	Ease of Implementation[3]	Community Acceptance[2]	Overall Score[3, 4]
WATER SUPPLY/TREATMENT				
Water blending	3	4	7	14 (10)
Shut down high nitrate wells	1	3	6	10
Alternative water supply (treatment plant or importation)	8	1	1	10
Point of use treatment	7	7	6	20 (5)
Eliminate shallow wells	3	2	3	8
BASIN REMEDIATION				
Flush and dilute basin	5	1	1	7
Site-specific soil remediation	4	2	5	11
Site-specific groundwater remediation	4	1	3	8
Interceptor wells	3	1	1	5
Basin-wide groundwater remediation	7	1	1	9

1 Please refer to " Chapter IX, Nitrate Management Alternatives" for explanation on how this table was developed.
2 Each alternatative was evaluated by District staff and ranked on a scale of 1 to 10, with 10 indicating a more favotable score.
3 The overall score for each alternative was computed by simple score summation of: water quality benefits + ease of implementation + community acceptance.
4 The values in parenthesis under the Overall Score column indicate the given alternative's relative ranking to all others based on its overall score, with 1 being the most valuable alternative.

TABLE 8[1]
Top Ten Management Alternatives—Numerical Screening and Subjective Analysis

- Public education
- Regulation of nitrogen fertilizer use
- Additional wastewater treatment
- Regulation of point sources
- Packaged wastewater treatment systems
- Point of use treatment
- Augment well seal standards for new wells
- Increase monitoring in private wells
- Water blending when possible
- Alternative water supply

[1] This list of top ten recommendations was developed based on the relative ranking computed for each alternative tested in Table 7 (see values in parenthesis under the Overall Score column).

X. SUMMARY OF RECOMMENDATIONS

The recommendations of our plan are separated into three categories: recommendations to reduce nitrate exposure, recommendations to reduce nitrate loading to Llagas Basin, and recommendations to monitor nitrate occurrence in Llagas Basin. The following paragraphs describe the specific recommendations within each category. A recurring recommendation throughout the categories is public education.

The District believes that one of the best means of prevention is to educate the public about the effects they have on the environment. The District is interested in developing community awareness of nitrate contamination in Llagas Basin. In a collaborative effort, agency representatives, water purveyors, members of the agricultural community, and water consumers can help protect our drinking water supply from further degradation while minimizing the economic impacts and exposure of consumers to nitrates.

RECOMMENDATIONS TO REDUCE NITRATE EXPOSURE

As mentioned in earlier sections of this report, elevated nitrate concentrations are of concern because of the susceptibility of infants to methemoglobinemia. Also, excess nitrates in food and drinking water may have long term carcinogenic or teratogenic effects on the exposed population. To help reduce the exposure of people to elevated concentrations of nitrates, the District makes the five following recommendations. It is important to point out that the recommendations are primarily directed at domestic well users. Municipal water supplies are tested and are safe to drink.

Public Education

The District believes that educating the people of the study area is one of the keys to successful nitrate management. We recommend that people of all ages and with various interests within the study area be educated about the occurrence of nitrates in groundwater, the health effects associated with nitrate contaminated groundwater, and ways to reduce exposure to elevated concentrations of nitrates. While municipal water supplies are safe, domestic well users need to be aware that nitrate may exist in significant concentrations in their tap water, and that measures exist to prevent the ingestion of such water.

For example, the District could educate the public about the alternatives to drinking nitrate-laden groundwater. The following paragraphs describe our recommendations with respect to these alternatives.

Alternative Water Supply (Bottled Water)

We recommend that part of our public education program include educating domestic well users about alternative sources of their drinking water. We can remind them that while their well is extracting elevated concentrations of nitrate-laden water, one option they have is to drink bottled water. Recommending such a measure can help reduce the number of people being exposed to nitrates, especially those who are particularly vulnerable to the effects of nitrates, such as infants.

Point of Potable-Water-Use Treatment

We also recommend that our public education program include point of potable-water-use treatment as a means of preventing exposure to elevated concentrations of nitrates from well water. Point of potable-water-use treatment consists of treating groundwater via ion exchange or reverse osmosis.

The District recommends working with public information professionals and the community to prepare and implement a comprehensive public education program.

Water Blending

Another means of reducing nitrate exposure in drinking water is to mix water with high nitrate concentrations with water with low nitrate concentrations. This action can help produce a drinking water supply with nitrate concentrations less than the Maximum Contaminant Level. Morgan Hill already implements this approach in the Llagas Basin area (personal communication with City personnel, 1995). We recommend and encourage Morgan Hill to continue with their approach. Also, we recommend that large commercial and industrial sites, which rely on well water for their supply, consider this approach. Perhaps all well owners could be educated about this approach as part of our public education program.

Review and Possibly Revise Well Standards for New Wells

We recommend that if we find that specific strata are contaminated, our well ordinance be revised so that the sanitary seal requirement for water wells installed in the southern portion of Santa Clara County be site and depth specific. Currently, a 50-foot minimum seal is required for any well installed in Llagas Basin; a 100-foot minimum seal, which extends across the entire thickness of the major aquitard, is necessary for wells completed in the confined zone. It is likely that in some parts of the study area, the current seal requirements are an insufficient length to protect against vertical migration of chemical compounds through the well or the well gravel pack or to protect well users from nitrate laden water from entering their wells.

District staff could also be available to review the well construction of wells which are producing high nitrate water, and to advise the well owner of possible well rehabilitation or reconstruction methods which may alleviate the problem.

Another aspect of the Well Standards which we believe should be reviewed and followed up with in more detail is backflow prevention. As discussed in our "Nitrate Source Areas Identification" report dated December 1994, the practice of chemigation directly feeds our groundwater supply with nitrogen-based compounds. According to District field personnel, this practice is becoming more wide spread over time (personal communication, 1995). Ensuring that proper backflow prevention measures are being implemented could help in reducing exposure to nitrates and in reducing nitrogen loading to our basin.

Future Considerations

Studies are still being conducted by EPA to determine the carcinogenic and teratogenic effects of nitrates. Also, many of the wellhead treatment alternatives in use today are quite costly. Rather than recommend such alternatives without knowing the carcinogenic and teratogenic effects of nitrates, the District is interested in using a lower capitol investment approach at first.

Regardless of our approach, we still find it necessary to present those recommendations which we considered and which are believed to have a higher capital investment. These recommendations are presented in the following paragraphs and are mentioned here with the intent that they will be evaluated for implementation 5 to 10 years from now.

Alternative Water Supply (Treated Surface Water)

Currently, the southern portion of Santa Clara County relies solely on groundwater for their drinking water supply. Depending on EPA's findings with respect to the carcinogenic and teratogenic effects of nitrates, and on the concentrations of nitrates in the groundwater of Llagas Basin, the District may need to consider an alternative source of drinking water.

Alternative Water Supply (Water Reclamation)

Another source of water for the Llagas Basin community can be made available via wastewater reclamation. Wastewater reclamation is a way to improve effluent quality as well as help solve our water supply needs.

RECOMMENDATIONS TO REDUCE NITRATE LOADING TO LLAGAS BASIN

As more nitrate studies are conducted throughout the country, the public is becoming more aware of the effects that its actions are having on the environment. We recognize that many people are already taking the initiative to reduce nitrate loading to Llagas Basin, already. However, the District believes that increased prevention now could help eliminate costly wellhead treatment later. The District makes the following five recommendations:

Public Education

As previously discussed, the District believes that public education is essential to an effective management plan. Besides educating people of all ages and with various interests about nitrates and ways to prevent exposure to them, the District is also interested in educating these people about ways to reduce their own nitrogen loading to the basin. We are recommending a collaborative effort between agencies, water purveyors, members of the agricultural community, and water consumers to help educate dischargers (both point and nonpoint) of nitrogenous compounds about ways to reduce their loading to the basin. These dischargers range from the private homeowner who fertilizers his/her lawn to the farmer who uses nitrogen-based commercial fertilizer.

We recommend that efforts of this public outreach be combined with the public education program for reducing exposure to nitrates. If implemented, we believe that this portion of our educational program will require the most coordination. We recommend tapping the resources and expertise of those directly working with nitrate dischargers. For example, we could sponsor a workshop where representatives of the Fertilizer Research and Education Program give a presentation on optimal fertilizer application rates for farmers. We believe that a broad based public education effort will promote civic and public awareness of the value of nitrate management practices such as optimization of fertilizer application and sewering existing and future densely developed areas.

Fertilizer Application Changes

Based on previous phases of our study, agricultural lands fertilized by nitrogen-based commercial fertilizers contribute the most nitrogen to our groundwater when compared to the other sources included in our study. The District is aware that many farmers are taking the initiative to reduce their own nitrogen loading to Llagas Basin by either optimizing fertilizer application or using alternative methods of fertilization. However, the District is concerned about those farmers who are unaware of such optimization practices. As part of the proposed educational program, we recommend that a more focused, proactive effort be placed on educating the agricultural community.

We recommend that the educational program for farmers include such topics as how to calculate the necessary fertilizer application rates by using nitrogen balances for their plots of land, and the importance of comparing their fertilizer application rates for specific crops with the average for all County growers, and with the optimum application rate determined as a result of experimental field research.

The District is confident that a comprehensive educational program targeted at the agricultural community would provide a solid foundation for reducing nitrogen loading to Llagas Basin. We believe such a program could help alleviate the need for further, more stringent reduction measures,

such as requiring tracking of nitrogen use, and requiring submittal of this data to an appropriate regulatory agency.

Increase Wastewater Treatment

The effluent of the Gilroy wastewater treatment facility has historically contained total nitrogen concentrations in the order of 30 mg/L. The treated wastewater is discharged to a pond system for disposal. Recently completed modifications to the treatment process have reduced to nitrate discharges to 5 mg/L or less. We recommend that evaluations be conducted during the course of the plant's operation to further determine whether the less concentrated effluent poses a threat to groundwater quality. This may be accomplished through monitoring well sampling or other means. This study is not specifically recommending the construction of an additional wastewater treatment plant; rather, it is recognizing measures to reduce nitrogen loading that are underway.

Increase Point Source Regulation

We recommend that nitrate-specific regulation of point sources be improved. We believe that the Regional Board should expand its definition of waste dischargers to include such known nitrogen sources as greenhouses and other currently unregulated dischargers. Perhaps waste discharge requirements for these facilities could be written to reduce nitrogen loading and its effect on groundwater quality.

We recommend that involved agencies, such as the County and the Regional Board periodically review the requirements for waste dischargers of nitrogenous compounds to ensure that monitoring and reporting requirements are consistent and effective for all dischargers. We recommend that these agencies improve follow up with waste dischargers, and consider requiring the remediation of nitrogen-laden soil at some locations which can act as a significant ongoing source of groundwater contamination.

Recharge Feasibility Studies

The District recommends that feasibility studies for recharge ponds and other structures which would introduce water into Llagas Basin should take into account the potential for these facilities to aid in the leaching and migration of nitrate contamination. Perhaps soil samples for nitrate analysis could be collected from soil borings down to at least 50 feet below ground surface. Long-term groundwater monitoring could also be incorporated into the operation plans for recharge facilities. We believe that adequate technical justification for the siting and operation of these facilities with respect to nitrate pollution should be demonstrated.

Future Consideration—Enhanced Sewage Treatment Technologies

Because residential development is expected to continue, a recommendation we may want to consider 5 to 10 years from now includes evaluating enhanced sewage treatment/disposal methods. One obvious alternative to using septic tanks is expanding the area connected to sanitary sewers. Also, on-site wastewater treatment systems for individual homes and residential/commercial communities would help to address nitrate loading issues. Community treatment systems, although not as ideal as municipal sewage treatment systems, provide a higher quality effluent than that from septic tanks and provide a more central and easily managed location for waste treatment. These systems lessen the nitrate loading potential of rural residential communities. It would be infeasible to convert all existing septic systems to on-site wastewater treatment plants, therefore, we would most likely recommend that all new developments use these systems. We also recommend that the County continue to encourage municipal sanitary sewer systems for any new or existing high density development, wherever feasible.

RECOMMENDATIONS TO MONITOR NITRATE OCCURRENCE IN LLAGAS BASIN

Collecting groundwater samples from the basin and analyzing for a suite of parameters is an effective way to monitor the health of the basin so that exposure to elevated nitrate concentrations can be minimized, and the effectiveness of the District's other nitrate management recommendations can be evaluated. The recommendations below address each of these points.

Increase Monitoring of Private Wells

The District recommends that monitoring of groundwater in private wells be increased from a one-time sampling of the well during installation to a minimum of once every five years. In accordance with California Code of Regulations, Title 22, the results of these sampling events should be forwarded to the appropriate agency for evaluation. Then, the appropriate agency would follow up with notification to the well owner of any potential health risk and need for alternative water supply.

Frequent monitoring could provide for earlier detection of water containing elevated nitrate concentrations and allow the consumer to temporarily replace the property's water supply prior to ingestion. As stated above, bottled water could be used as a short-term water supply until a longer-term alternative water supply, such as point of potable-water-use treatment, is implemented.

Expand District's Basin-Wide Groundwater Quality Monitoring Program

Since approximately 1984, the District has sampled groundwater from up to 25 wells located throughout the County as part of its Basin-wide Groundwater Quality Monitoring Program. The groundwater from these wells is sampled every few years and analyzed for a suite of parameters. These parameters have included general minerals, nitrates, pesticides, herbicides, Volatile Organic Compounds, coliform, and radionuclides.

The overall purpose of the program is to help the District understand the general groundwater quality health of the basins within its jurisdiction. With an increased difficulty in obtaining access to the privately owned wells in our monitoring network, as well as an advancement in technology, the District believes that the existing program needs to be augmented and expanded.

The District believes that enhancing and implementing the Basin-wide Groundwater Quality Monitoring Program will be a means of monitoring the effectiveness of our other nitrate management recommendations over time.

XI. IMPLEMENTATION OF NITRATE MANAGEMENT RECOMMENDATIONS

Implementation of our nitrate management recommendations requires a collaborative effort between agencies, water purveyors, members of the agricultural community, and water consumers, a reasonable timeframe for implementation, and financial support. Each of these requirements is discussed in more detail below. Also, limitations associated with implementation of our recommendations are discussed.

RECOMMENDED IMPLEMENTING AGENCIES

The paragraphs below identify those entities that we believe should be involved in implementation of our recommendations. A general description of each entity's roles and responsibilities is outlined followed by a description of how the District would like to work with these agencies on implementation of our nitrate management recommendations. Further clarification of the roles and responsibilities of each agency will occur during the implementation phase as coordination meetings are held for each recommendation.

Santa Clara Valley Water District

The District is the agency primarily responsible for wholesale water supply in Santa Clara County and management of the groundwater basins. The District has been coordinating this study and will continue to coordinate the implementation of nitrate management recommendations.

The District proposes to coordinate with agencies having authority to implement the recommendations. The District expects to take the lead in developing the public education program, reviewing and possibly revising the well standards for new wells, conducting recharge feasibility studies, and augmenting and expanding the Basin-Wide Groundwater Monitoring Program. We also expect to monitor the progress of other agencies activities, such as the Central Coast Regional Water Quality Control Board follow up on facilities not complying with their WDRs.

Central Coast Regional Water Quality Control Board

Regional Boards are responsible for developing Basin Plans, documents which outline water quality management goals for each of its regions. The study area is within the Regional Board's jurisdiction, and the Regional Board is responsible for WDRs for point sources of pollution in Llagas Basin. The Regional Board also may issue Cleanup and Abatement Orders for contaminated sites. NPDES permits, which regulate water discharges to storm drains or water courses, are also issued by the Regional Board.

During implementation of the nitrate management recommendations, we recommend that the Regional Board have primary responsibility for increasing point source regulation. Responsibility for this recommendation would include expanding on responsibilities it already has, such as issuing WDRs, NPDES permits, and Cleanup and Abatement Orders, which pertain directly to nitrate pollution of groundwater.

Santa Clara County

The Santa Clara County, Department of Planning and Development (County Planning) is responsible for administering land use zoning ordinances and other actions as determined by the County Board of Supervisors and the County Planning Commission.

As nitrate management recommendations are implemented, County Planning would continue to be responsible for making recommendations to the County Planning Commission and Board of Supervisors with regards to amendments to land use permits and zoning requirements.

The Santa Clara County Department of Environmental Health (County Environmental Health) is responsible for environmental and human health. County Environmental Health staff review groundwater quality data from a newly installed well during system clearance for a building permit. If water quality does not meet safe drinking water standards, County Environmental Health staff require that those well owners treat the water and obtain final water system clearance before obtaining a building permit (**personal communication** with County Environmental Health staff, 1995).

County Environmental Health also administers the Private Sewage Disposal Ordinance, which contains guidelines for the construction and operation of septic tank systems (personal communication with County Environmental Health staff, 1995),

We recommend that the roles and responsibilities of County Environmental Health include increasing the monitoring frequency on private wells. Responsibility for this recommendation would include being responsible for reviewing the results of well sampling, and requiring treatment of contaminated water or an alternative water supply for well owners whose wells produce water with nitrate greater than MCLs.

Farm Bureau of Santa Clara County

The Farm Bureau of Santa Clara County (Farm Bureau) is a "grassroots" organization which provides support to farmers via agricultural educational programs and assistance with legal issues.

We foresee the Farm Bureau as a valuable resource during the implementation of our recommendations, especially during development and implementation of our public education program.

California Department of Food and Agriculture—Fertilizer Research and Education Program

The Fertilizer Research and Education Program (FREP) was created to advance the environmentally safe and agronomical sound use and handling of fertilizer materials. Much of FREP's work is concerned with nitrate contamination of groundwater.

Program activities are directed to serving growers, public agencies, agricultural supply and service organizations, extension personnel, resource conservation and irrigation districts, consultants, the general public and other interested parties.

Like the Farm Bureau, we see FREP as a valuable resource during the development and implementation of our public education program. FREP is most knowledgeable about optimal farming techniques and is a well-respected agency with agricultural experts.

University of California at Davis—Cooperative Extension

University of California at Davis—Cooperative Extension (UC-Davis) performs research associated with agricultural activities and educates the agricultural community about various agricultural issues.

UC-Davis would provide expertise in farming techniques and could also be a resource during the development and implementation of our public education program.

We expect to continue to work with the Santa Clara County Department of Environmental Health to identify treatment technologies that will have the net effect of reducing nitrate loading to the basin.

State of California—Department of Health Services

DHS is a state agency and its staff review and evaluate the groundwater quality data of public water systems (**personal communication** with County Environmental Health staff, 1995).

We forsee DHS continuing with its current responsibilities as we implement nitrate management recommendations.

Cities of Morgan Hill and Gilroy

The two cities in the study area act as water retailers, and as such, are responsible for the quality of water delivered to the consumer. The cities also maintain and operate their respective water supply wells, and administer water blending operations.

During implementation of the management recommendations, the cities would be responsible for continuing or modifying their water blending programs, and continuing to monitor their water quality to help reduce nitrate exposure.

Other Water Retailers

The water retailers are responsible for delivering their customers water which contains less than MCL concentrations.

Water retailers would be responsible for insuring water delivered to consumers contains water which does not exceed the MCL for nitrates.

Waste Dischargers

Currently, waste dischargers of nitrogenous compounds are knowingly or unknowingly discharging to the soil, groundwater, or surface waters of the study area. They may or may not be monitoring and reporting their discharges.

During implementation of our nitrate management recommendations, we hope to educate these dischargers and gain active participation in reducing the nitrate loading to Llagas Basin.

Community of the Llagas Basin Area

The people of the Llagas Basin area maintain a livelihood and use the groundwater of Llagas Basin as their drinking water supply. As part of the implementation process, we propose to educate the public about its drinking water supply, more specifically the elevated concentrations of nitrates that have been seen in this southern most portion of our County, the health effects associated with these elevated concentrations, ways to reduce nitrate exposure, and ways to reduce their own nitrate loading to the basin. Our goal would be to achieve full community participation so that the quality of the drinking water supply of Llagas Basin is improved and sustained for future generations to come.

RECOMMENDED IMPLEMENTATION SCHEDULE

We recommend that implementation of the nitrate management recommendations occur within 6 months following submittal of the Final Report to the State Water Resources Control Board. The District foresees the first phase of implementation being contacting and coordinating with other agencies to develop initial detailed schedules for implementation of each recommendation. Implementation of the recommendations will depend upon the outcome of our coordination meetings.

We believe that the public education program should be the first recommendation considered for implementation. This program would address reducing nitrate exposure and reducing nitrate loading to Llagas Basin. This program will also require the most coordination within the District as well as entities outside the District. Some issues which may play a role in implementation of our recommendations are discussed in more detail below.

PROPOSED IMPLEMENTATION COSTS

Table 9 provides rough estimates for the cost of implementing our recommendations. Some of the recommendations are already being implemented, therefore estimated costs that you see are for ongoing operational-type costs. For those recommendations, such as a public education program, that are newly created, estimated start-up costs are provided. The District, along with the appropriate agencies, will prepare a more detailed cost estimate for implementation once consensus is reached regarding the specifics of the recommendations.

FINANCIAL CONSIDERATIONS OF IMPLEMENTATION

The development of our recommendations included sensitivity to the cost of implementation. Thus, the actions were selected based on minimizing impact on the involved agencies and individuals, and using an overall lower capital investment approach.

There are three primary financial considerations for implementing our nitrate management recommendations. The first consideration is whether or not a regular, reliable and consistent funding source for nitrate management will exist for those entities involved in implementation of the recommendations. Funding sources exist at the state and federal level as grants. However, grants are not usually a regular funding source. Another possible source of funding is through the state budget. Based on experience over the last several years, the California state budget is also not necessarily reliable or consistently able to provide the funding levels required. Other possible sources of funding include permit fee structures, property taxes, or direct cost recovery. These sources are currently being used for funding cleanup of leaking underground storage tanks and for prevention of non-point source pollution. It may be possible to use this approach for cleanup of severe nitrate sources.

The second financial consideration is whether or not funds from the District's Water Utilities account should be used for implementing our recommendations.

The third consideration is that cost estimates will need to be developed with other entities in order to determine their overall cost.

OTHER IMPLEMENTATION CONSIDERATIONS

The District anticipates that some financial and staff resource constraints may delay or prevent the implementation of our nitrate management recommendations. The priorities of the implementing agencies involved may not include nitrate management. Thus, the constraints on each of the implementing agencies may be a deciding factor in the implementation time frame of our recommended actions. Although the recommendations discussed in this report have been reviewed by the agencies that would be involved, final concurrence by the implementing agencies is also necessary for successful implementation. Lastly, changes in legislation beyond our control could impact implementation of some or all of the recommendations we have presented in this report.

TABLE 9
Proposed Implementation Costs

Recommendation Categories	Proposed Costs	Status
Recommendations to Reduce Nitrate Exposure		
Public Education consisting of exposure and occurrence	$75,000	New
Water Blending	Morgan Hill	Ongoing
Recommendations To Reduce Nitrate Loading To Llagas Basin		
Public Education	See above estimate	New
Increase Wastewater Treatment	Incurred already	Ongoing
Increase Point Source Regulation	Regional Board	New
Recharge Feasibility Studies	$60,000/project	New
Recommendations To Monitor Nitrate Occurrence in Llagas Basin		
Increase Monitoring in Private Wells	County Environmental Health	New
Augment and Expand District Groundwater Monitoring Program	$200,000	New

Note: Proposed costs for water blending, increasing point source regulation, and increasing monitoring in private wells will be developed during implementation with the appropriate agencies.

XII. IMPLEMENTATION EFFECTIVENESS EVALUATION

We plan to evaluate the effectiveness of our nitrate management plan implementation by preparing an Implementation Evaluation Checklist and submitting a completed version of this checklist on an annual basis to the State Board. This checklist is required by our contract with the State Board.

As you can see by reviewing a copy of this checklist in Appendix C, the District has included some quantifiable measures of success. Each nitrate management recommendation has quantifiable measures of success. Based on the results of the implementation effectiveness evaluations, the District may revise some of its original recommendations. Also, changes in legislation may require the District to change some of its implemented recommendations. The District does not expect to see the effects of some of its recommendations for 20 to 30 years.

XIII. CONCLUSIONS

Historically, groundwater from municipal and private water supply wells in the Llagas Basin area has been found to contain concentrations of nitrate greater than those allowed by federal safe drinking water standards. As a result of conducting this study, we were able to confirm that nitrate-laden groundwater continues to threaten full use of the basin as a source of water for the Llagas Basin community and that many categories of nitrate dischargers have contributed and continue to contribute to the nitrate loading. With assistance from the State Board, our TAC, other committees, agencies, and the community of Llagas Basin, we also developed measures to reduce nitrate exposure, to reduce nitrate loading, and to monitor nitrate occurrence in Llagas Basin.

APPENDIX A
REFERENCES

REFERENCES

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APPENDIX B
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APPENDIX C
IMPLEMENTATION EVALUATION CHECKLIST

IMPLEMENTATION EVALUATION CHECKLIST

COORDINATION MEETINGS WITH APPROPRIATE AGENCIES INITIATED		
Nitrate Management Recommendation	Proposed Date	Actual Date
Public education	April 1, 1996	
Water blending	July 1, 1996	
Review and possibly revise well standards	April 1, 1996	
Future considerations	January 1, 2000	
Increase wastewater treatment	Implemented	Implemented
Increase point source regulation	July 1, 1996	
Recharge feasibility studies	July 1,1996	
Increase monitoring frequency of private wells	July 1, 1996	
Expand the District's Basin-Wide Groundwater Quality Monitoring Program	July 1, 1996	

DETAILED IMPLEMENTATION SCHEDULE DEVELOPED AND ACCEPTED BY THE APPROPRIATE AGENCIES		
Nitrate Management Recommendation	Proposed Date	Actual Date
Public education	January 1, 1997	
Water blending	January 1, 1997	
Review and possibly revise well standards	January 1, 1997	
Future considerations	January 1, 2001	
Increase wastewater treatment	Implemented	Implemented
Increase point source regulation	January 1, 1997	
Recharge feasibility studies	January 1, 1997	
Increase Monitoring Frequency of Private Wells	January 1, 1997	
Expand the District's Basin-Wide Groundwater Quality Monitoring Program	October 1, 1996	

IMPLEMENTATION EVALUATION CHECKLIST (CONTINUED)

DETAILED BUDGET DEVELOPED AND ACCEPTED BY THE APPROPRIATE AGENCIES		
Nitrate Management Recommendation	Proposed Date	Actual Date
Public education	January 1, 1997	
Water blending	January 1, 1997	
Review and possibly revise well standards	January 1, 1997	
Future considerations	January 1, 2001	
Increase wastewater treatment	Implemented	Implemented
Increase point source regulation	January 1, 1997	
Recharge feasibility studies	January 1, 1997	
Increase monitoring frequency of private wells	January 1, 1997	
Expand the District's Basin-Wide Groundwater Quality Monitoring Program	October 1, 1996	

IMPLEMENTATION OF DETAILED SCHEDULE		
Nitrate Management Recommendation	Proposed Implementation Date	Actual Implementation Date
Public education	February 1,1997	
Water blending	February 1,1997	
Review and possibly revise well standards	February 1,1997	
Future considerations	February 1,2001	
Increase wastewater treatment	Implemented	Implemented
Increase point source regulation	February 1,1997	
Recharge feasibility studies	February 1,1997	
Increase monitoring frequency of private wells	February 1,1997	
Expand the District's Basin-Wide Groundwater Quality Monitoring Program	June 30, 1996	

LLAGAS GROUNDWATER BASIN NITRATE STUDY
RESPONSIVENESS SUMMARY

During the Focus Meeting on September 28, 1995, and the Public Workshop on December 12, 1995, the Santa Clara Valley Water District (District) solicited input from the Technical Advisory Committee, representatives of state and local agencies, District Board members, and the public. These answers are in response to specific questions and comments raised concerning the Draft Final Report, dated August 1995. Most of the questions were incorporated into the report itself and/or will be addressed in the implementation phase. Duplicate questions were consolidated, and questions serving only to provide clarification to the discussion were eliminated.

GENERAL

1. How many wells have been sampled?

The District reviewed historical data for 837 wells and sampled and analyzed 28 wells (pages 8-23,27) for this study.

2. How many cases of methemoglobinemia have been reported in Llagas Basin?

The number of cases of methemoglobinemia in Llagas Basin is unknown due to the lack of requirements for the reporting of cases. It is likely that some individuals have suffered early stages or symptoms of methemoglobinemia without report (Nitrate and Nitrite in Drinking Water, National Academy Press 1995) and were not aware of the link to nitrate exposure.

3. Where is the water blended?

Water blending, or mixing water with high nitrate concentrations with water with low nitrate concentrations, can help produce a drinking water supply with nitrate concentrations less than the Maximum Contaminant Level (MCL). Municipal water suppliers have testing requirements that are not imposed on private well owners. These testing requirements are designed to ensure a supply of safe drinking water for municipal water customers.

The cities of Morgan Hill and Gilroy are responsible for the quality of water delivered to their customers and currently administer water blending operations as needed. "During implementation of the (District's) recommendations, the cities would be responsible for continuing or modifying their water blending programs" (page 70). The District also recommends that "large commercial and industrial sites consider (water blending)" and plans to educate owners of domestic water supply wells about this approach as part of the public education program (page 64).

4. Is the imported water used for District recharge operations currently tested?

Water imported for use in groundwater recharge operations is tested before it is used.

5. **Is there a way to chemically alter nitrate (i.e., put additives in septic tanks)?**

The District is aware of the current use of bacteriological remediation of effluent at some sewage treatment facilities and new septic tank systems are being developed that will reduce nitrate discharges.

6. **Maybe members of the Nitrate Study should coordinate efforts with Mr. Scott Akin (of the District's Water Conservation Group.)**

Discussions have already taken place concerning the coordination of efforts between groups. Members of the Nitrate Study Team are currently exploring ways to best combine efforts.

7. **A correction should be made on page 69 to read, "and human health" as opposed to "not human health."**

Changes have been made to read, "County Environmental Health is responsible for environmental and human health" (page 69).

8. **Correction: "California Administration Code" should be changed to the "California Code of Regulations."**

Corrections have been made to the report.

9. **Change the wording on page 63 from "point of use" to "point of potable water use" to ensure consistent definition of terms amongst agencies.**

Changes have been made to the report.

10. **On page 48 of the report, the wording should be changed to clarify the intent of the Basin Plan. The Basin Plan requires a groundwater quality standard of 5 milligrams per liter (mg/L) nitrate nitrogen, not a 5 mg/L standard for the discharger.**

The wording has been changed to more accurately reflect the intent of the Basin Plan.

11. **Beginning on page 45 with the discussion of "Point Source Institutional Mechanisms," please clarify that not all agriculturally-related dischargers are regulated. The Central Coast Regional Water Quality Control Board (CCRWQCB) determines whether or not to regulate a facility based on the potential for the operations associated with that facility to degrade water quality. In other words, if it appears that potential problems may exist, the CCRWQCB would most likely regulate that facility. However, if the facility is properly managing wastes, etc., and appears to not pose a threat to groundwater quality, then the CCRWQCB will most likely not regulate the facility.**

A statement has been added to the opening paragraph of that section to clarify how point sources are regulated by the CCRWQCB. Wording in each of the subsections (e.g., dairies) has been changed accordingly, as well.

12. **Footnotes to Table 7 would help clarify the contents of the table.**

Footnotes explaining the contents of the table have been added.

DATA REVIEW/DATA ANALYSIS

13. The report should give the public some information regarding how the city wells are testing, as well as some information on how nitrates impact human health.

As part of the historical data review, the District reviewed approximately 837 wells (page 8). This phase of the study is discussed in more detail in the "Nitrate Data Review" report, dated August 1993. The District sampled and analyzed 28 wells for the study, and general concerns about the water quality in the basin should be directed to the water supplier and/or County Environmental Health. Impacts of nitrates to human health are addressed on pages 1 and 8 of the "Draft Final Report."

14. In the Sample Analysis section of the report, nitrate concentrations are discussed. CCRWQCB recently prepared nitrate isocontours for Llagas groundwater basin. The District may want to take a look at them for comparison purposes.

The Sample Analysis phase of the study has been completed. However, the District is working to obtain copies of the CCRWQCB's nitrate isocontours. The District will continue to monitor nitrate occurrence as part of the Basinwide Groundwater Quality Monitoring Program, and CCRWQCB's information will supplement information the District plans to gather.

15. Why does the District think the trend indicates increasing nitrate concentration?

The District's sampling data supports "the generally increasing trend of nitrates (seen) in the historical data review . . . Graphs depicting (the) trend analysis are shown in Figures 13 through 18" (page 31).

16. How did the District take into account differences in seasons of sampling?

The District sampled and analyzed 28 wells in December 1993 (before winter rains) and March 1994 (after winter rains). Nitrate concentrations of December's sampling event varied only slightly as compared to that of March's. Certain wells sampled higher nitrate concentrations in December, while others had higher concentrations in March.

17. Did the District look at any samples of run off?

To accurately calculate nitrogen loadings from rainwater as a source, an intensive study should be performed. Such a study is beyond the scope of this project. However, rough estimates of the nitrate loadings were made and calculated in the "Nitrate Source Area Identification" report, dated December 1994 (Appendix B), and samples of rainwater were collected and analyzed as part of the study.

18. What kinds of well construction data (e.g., depth) was known?

Complete well construction information was available for 25 of the 28 wells that the District sampled. The District outlined the well construction information in Table 3 (pages 24 to 26), including well depths and screened intervals. Sample results indicated only a loose correlation between well construction and nitrate concentrations; nitrate concentrations were lower in wells deeper screened intervals (see below).

19. Is there any correlation between concentrations and depth?

Nitrate is present at all depths sampled. Of the wells sampled by the District, the general trend showed lower, but not insignificant, nitrate concentrations in deeper water-bearing zones. Discussion of the vertical distribution of nitrates is found on page 21 of the "Sample Analysis" report, dated May 1995. Figures 5 through 7 summarize the findings.

20. The city wells are about 600 feet deep; are they being tested?

All municipal (city) wells are tested on a regular basis. Any water from these wells with nitrate concentrations above the MCLs is either treated and/or blended. City well data was incorporated into the District's study of historical data; however, no city well data was included in analysis of current trends.

SOURCE AREA IDENTIFICATION

21. Is the aquifer recharged from outside the basin? If so, the nitrate could be coming from outside the basin.

No. The groundwater in Llagas Basin originates in the Llagas Basin Drainage. Groundwater north of Cochran Road flows north and ultimately to the San Francisco Bay. Groundwater flows south from Cochran Road and is recharged from waters flowing from the Santa Cruz Mountains and the Diablo Range. Groundwater in the basin continues to flow south until it reaches the Pajaro River. Nitrates found within Llagas Basin originate within the confines of the Llagas Basin Drainage.

22. There is a concern for contamination of downgradient wells from upgradient sources.

This is a valid concern, but it is difficult to determine up and downgradient relationships and if the nitrate found in a specific well originated from a known upgradient source. "Preferential migratory pathways and irregularities in local groundwater flow may exist and can cause a distant nitrate source to actually become a significant source" (page 38). Also, "due the nature, extent, and number of potential nitrate source in Llagas Basin, it is difficult to determine the exact amount of nitrogen loading contributed by each particular source. Detectable concentrations of nitrate discovered in a well today may be from a single source, or from a combination of sources. Past nitrate management practices, or lack of them, may still be affecting groundwater quality in the basin, because transport and transformation of nitrogenous compounds from the ground surface to groundwater may take months or years depending on local subsurface conditions" (page 20). The reality that "nitrates in any given well may originate from a mix of two or more sources," (page 38) supports the need to implement the District's recommendations to reduce nitrate loading and monitor nitrate occurrence in Llagas Basin.

23. The report does not represent the real problem of chemigation—specifically the hazards and seriousness. Chemigation, however, may not necessarily be a problem if addressed correctly. It needs to be addressed in the regulations.

The existing regulations concerning chemigation (page 45) require backflow prevention devices on all wells using chemigation. The District will begin work with the agricultural community to ensure that backflow prevention devices are installed on all wells utilizing chemigation.

24. Where are most of the septic tanks? Are they in any particular concentrated location?

Septic tanks are located throughout the entire basin, though "the areas of San Martin and certain unincorporated areas of Gilroy and Morgan Hill are the most likely areas to have significant nitrate contributions from septic tanks" ("Nitrate Source Area Identification" report, page 17).

25. Please explain how the sample calculation for nitrogen loading from fertilized agricultural lands was derived. Where did the numbers come from?

The average nitrate application rate for crops was obtained via interviews with farmers in the area and from the Santa Clara County Farm Bureau. A discussion of how the District performed the actual calculations for loadings by nitrogen-fertilized agricultural lands is found on pages 13 and 16. These calculations are "based on equations from the State Department of Water Resources land use surveys, Agricultural Chemical Usage Reports by United States Department of Agriculture, Survey of Fertilizer Use in California by the Division of Agricultural Sciences at the University of California, and information from experts and technical literature (page 13). In particular, sample calculations and other pertinent data presented in the Guidance Manual at UC Davis are used wherever appropriate and/or applicable" (page 12). The sample calculation is found in Appendix B of the "Nitrate Source Area Identification" report, dated December 1994.

26. Looking at Table 6 (page 36): What about pre-1990 data for agricultural land fertilized with cattle manure?

Although the District looked at land use information and relative loadings for the different nitrate sources since 1967, some specific loadings were not available for years prior to 1990. The data available is listed in Table 6 (page 36).

27. What is the impact of clippings as opposed to commercial fertilizer application?

Clippings as a potential source of nitrate contamination was not specifically addressed in the District's "Draft Final Report;" however, the University of California at Davis (UCD) discussed the two sources (clippings versus commercial fertilizer) in a report titled, "Identification and Evaluation of Methods for Determining Sources of Nitrate Contamination in Groundwater" (June 1994). In UCD's report, nitrogen isotope ratios of fertilizer sources "could not be distinguished from that of native soil organic matter." In areas where both clippings and commercial fertilizers are applied to the soil, it is nearly impossible to determine the impact of each individual source.

28. Did the District look at the loadings of horse manure in San Martin?

The "Nitrate Source Area Identification" report, dated December 1994, discusses the nonpoint source nitrate loadings from horse manure in the section entitled, "Domestic Livestock" (pages 19-20). Loadings are calculated basinwide, not just in San Martin, and other domestic livestock such as sheep and lambs were included in the report.

29. It seems that the sewage facility probably contributes more nitrates than all septic tanks combined.

On page 36, Table 6 summarizes the relative contributions of all point and nonpoint sources in Llagas Basin. Based on the District's calculations, the potential contribution from all septic tanks in the basin totals 53,000 to 151,000 pounds of nitrogen per year. Because of treatment to reduce

nitrate, sewage treatment facilities in Llagas Basin potentially contribute approximately 2,100 to 3,100 pounds of nitrogen per year.

30. What do earlier reports say about the area around the sewage farm?

Sewage disposal pits were historically used but are no longer in use today. Calculations for the potential nitrogen loading were included in the study and reflect a relatively small contribution as compared with septic tanks and fertilized agricultural lands ("Nitrate Source Area Identification" report, page 34). Greater discussion of sewage disposal pits and their contribution of nitrates in Llagas Basin is found in the "Nitrate Source Area Identification" report, dated December 1994.

31. The sewage plant mentioned in the study is now testing at approximately 5 mg/L, which is below the MCL (10 mg/L).

The District used 1993 sewage plant discharge data to calculate potential nitrogen loadings from the sewage plant. The District will edit the report to inform readers of the new discharge level.

32. Are landfills currently monitored for nitrates?

Yes, landfills are already monitoring many analytes including nitrate.

IMPLEMENTATION

33. How will the report/study impact the North County?

Although the study addresses sources and loading potentials characteristic to the entire Santa Clara County, the recommendations are geared to reduce nitrate exposure, to reduce nitrate loading, and to monitor nitrate occurrence in Llagas Basin (not countywide). Specific reliance on groundwater as a drinking water source and the severity of nitrate impact from fertilized agricultural lands, septic tanks, cattle feed lots, and egg farms is unique to the South County. This report's recommendations address the needs and protection of the Llagas Basin based on this unique impact and reliance. Possible future recommendations for the North County may be similar or identical to ones in this report.

34. What are the environmentally-correct alternatives to individuals? These alternatives should be considered in the report.

The District appreciates the concern for environmentally-correct alternatives and plans to encourage the use of the alternatives to individuals through the public education program. At that time, these alternatives will be explained in more detail.

35. Who enforces the regulations and recommendations? Where is the money coming from?

Several entities currently enforce regulations regarding land use, water quality, and nitrate contamination. These entities are described in the "Public Draft Final Report" (pages 68 to 70) as agencies the District recommends for implementing the recommendations. Existing institutional mechanisms and related agencies are described on pages 40 to 49, with the Regional Water Quality

Control Board (RWQCB) as the primary regulatory agency. Funding for implementation will come from various sources. Proposed costs are discussed on page 71 and listed in Table 9 (page 73).

36. Based on recommendations from the District, how likely will the RWQCB enforce land use regulations that are not currently being enforced?

The District recommends improving and increasing point source regulation. One way is by expanding the definition of waste dischargers to include those that are currently unregulated, such as greenhouses. Enforcement of existing regulations is ultimately up to the RWQCB. The District will work with the RWQCB to ensure that any nitrate management recommendations that include RWQCB enforcement are implemented.

37. How can the public obtain point-of-use treatment systems?

This type of information will be addressed in through public education.

38. What groups will the District be working with during implementation?

The District will gather input and coordinate with various agencies and groups, as needed. A collaborative effort between agencies, water purveyors, members of the community, and water consumers is planned. A list of recommended implementing agencies is found in the "Draft Final Report" (pages 68 page 70), including a description of their current and/or anticipated roles and responsibilities. The District is already working closely with the Fertilizer Research and Education Program to develop a comprehensive education outreach to the agricultural community.

39. If the recommendations are implemented, there are needs to be a funding source for County Environmental Health monitoring. Currently, monitoring is voluntary. Where is the money going to come from to increase monitoring of private wells?

The District believes that increasing the frequency of private well monitoring is a viable way to monitor nitrates in the basin, thereby protecting human health. Private monitoring is relatively inexpensive; well owners would pay for monitoring.

40. Backflow prevention will have difficult implementation, no matter what.

The District recognizes the problems associated with backflow prevention implementation. Through public education, the District plans to inform well owners of the problem and provide possible solutions. The District will work with the agricultural community to ensure that backflow prevention devices are present on all wells utilizing chemigation.

41. How will the recommendations for alternatives to septic tanks affect property owners?

The District plans to outreach to property owners concerning septic tanks as part of the public outreach program. Alternatives to septic tanks will be considered for implementation 5 to 10 years from now (page 64).

42. **On page 51 of the report, an on-site sewage disposal system is suggested as an alternative to septic tanks. The CCRWQCB doesn't feel comfortable with this alternative system as a solution. Santa Cruz Environmental Health Department has more information regarding these systems.**

The information in Table 6 (page 51) is the result of brainstorming sessions held at the first few Technical Advisory Committee meetings. This option is not an option the District recommends at this time. However, as seen on page 64, this option may be considered 5 to 10 years from now as an alternative to septic systems. The District appreciates your input and will contact Santa Cruz and other entities about their experiences with septic tank alternatives.

43. **The report should list another option to the recommendations: wastewater reclamation. Wastewater reclamation is a way to improve effluent quality as well as help solve our water supply needs. More research is needed.**

The District has mentioned this option under Future Considerations. In other words, this is an option to be considered 5 to 10 years from now, when additional information is gathered about nitrate occurrence in the basin and about the benefits of wastewater reclamation.

44. **There are concerns to people in the study area regarding property value. Also, there is an expected increased market of water treatment systems after implementation.**

The District hopes to educate both realtors and the public on this issue.

45. **The CCRWQCB agrees that point source regulations should be increased; however, staffing and funding limitations currently exist.**

The District appreciates CCRWQCB's support of the recommendation and agree that some limitations may exist when trying to implement these recommendations. However, the District plans to work with the appropriate agencies to resolve such issues as schedules, budgets, and staffing.

46. **Are there any recommendations concerning leach lines?**

All the recommendations are outlined on pages 63 page 67 and none specifically address leach lines. Future considerations may address this concern 5 to 10 years from now.

47. **What specific public education information approach is planned? Maybe the District could supply brochures or pamphlets to the public with basic information such as: "Things that are in your water."**

The report provides an overview of the public outreach planned (pages 63,65) but the District will take this suggestion into account during implementation and public outreach.

48. **Would it be beneficial to put together a layperson's version, especially concerning public outreach? Also, maybe some of the tables/numbers could be summarized on some type of loose-leaf page in the front of the report.**

This report is actually a summary of the study already. However, the District concurs that a plain-language summary would be beneficial. One is now available from the District. This fact sheet includes a brief explanation of the study and District recommendations.

49. **Part of the public outreach could include information about "Where the water comes from."**

The District will address this concern through public education.

50. **During the implementation of the agricultural portion of the public education program, the District should look at the Coastal Zone Management Act for ideas.**

The District plans to obtain this document and review it during the implementation phase.